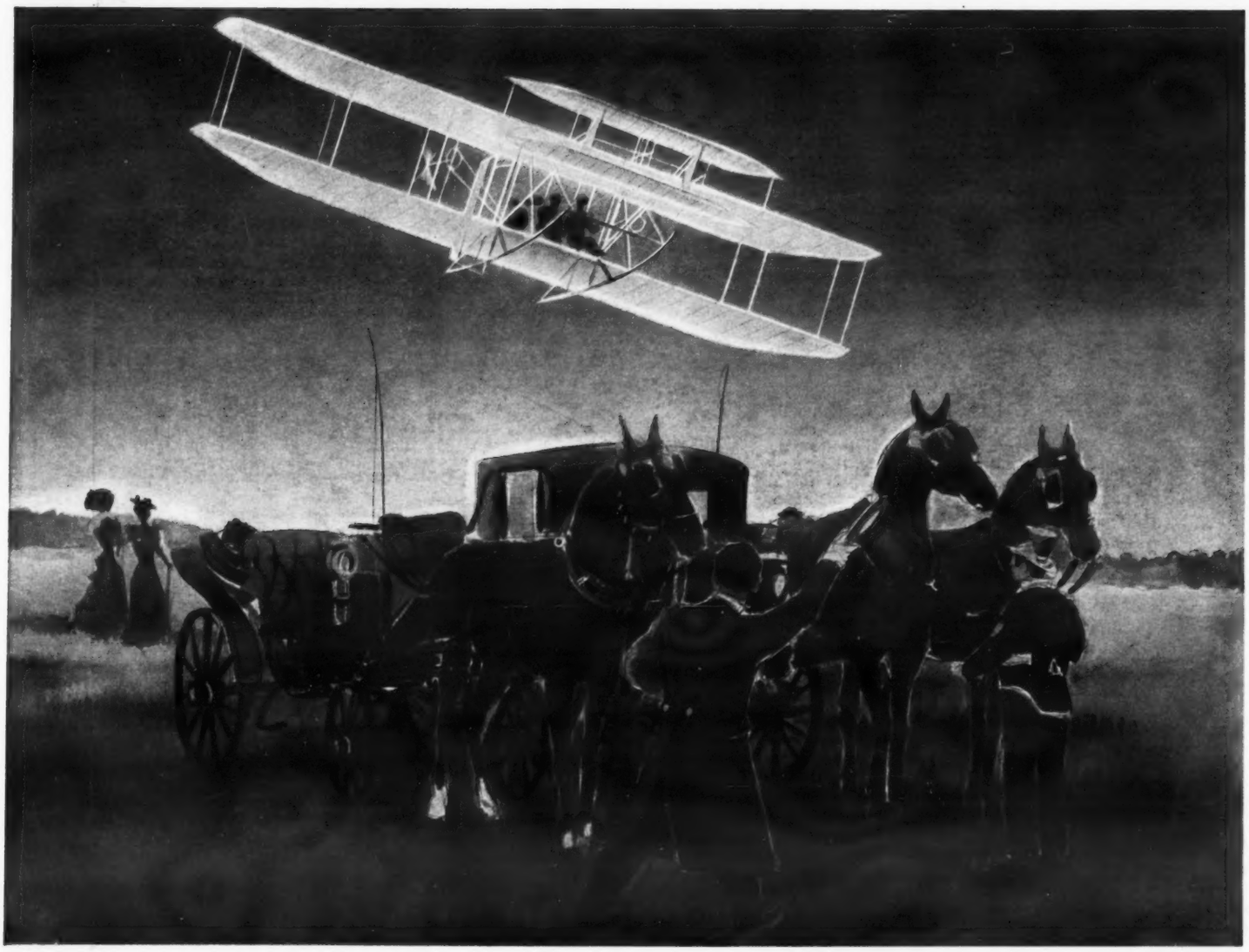
INTERAVIA

REVIEW OF WORLD AVIATION



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IN THIS ISSUE

50 Years of Powered Flight

VOLUME VIII **12** 1953

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Whatever your place in aviation, or whatever you plan to do, Bendix merits a place in your plans. This constantly growing organization of 6,000 engineers, 14 research centers and 19 manufacturing plants builds more different products for aviation . . . concentrates a wider range of skills and talents on its problems . . . and has accelerated progress in more directions than any other single company. For example, Bendix is presently engaged not only in forwarding commercial flight, but is also deeply engaged with . . .

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Review of World Aviation

Volume VIII — No 12 — 1953

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Contents

FIFTY YEARS OF POWERED FLIGHT

Epic Moments in Aviation		691
The Birth of Flying	W. COPPENS DE HOUTHULST, Brussels	692
Men Have Been Flying for Fifty Years	Ch. DOLLFUS, Paris	694
An American's Comments on the Wright Brothers' Anniversary	W. H. WAGER, New York	704
Faster and Higher		706
Thirty-three Years of Aircraft Manufacture	F. W. CONANT, Santa Monica	708
From Glue-Pot to Hall of Giants	H. L. HIBBARD, Burbank	709
Grandfather Taught us How	G. VOISIN, Paris	711
A Test Pilot Reminisces	J. L. PARKER, Belfast	713
1953 and On...	Sir ROY H. DOBSON, Manchester	716
Germany's Contribution to Aviation	W. MESSERSCHMITT, Munich	717
Memories of a Designer	E. HEINKEL, Stuttgart	718
The Weapons System	P. M. GALLOIS, Paris	719
What's in the Air ?		723
The Piloted Delta-Wing Interceptor	A. BURET, Paris	725
The F-100 " Super Sabre "		727
The Mind of Mr. Reader		728

Front cover :

Wilbur Wright demonstrated his aircraft in France in August 1908, making flights of 1 hour 9 minutes and 1 hour 31 minutes at Hunaudières and Auvours Camp.

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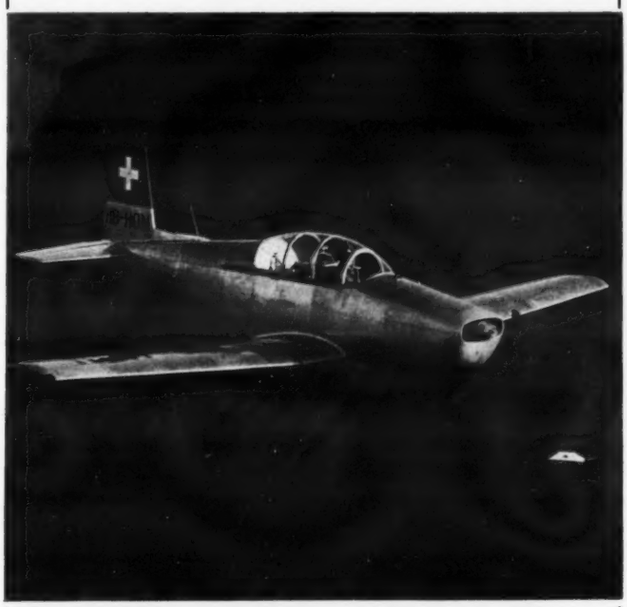

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United Airgram

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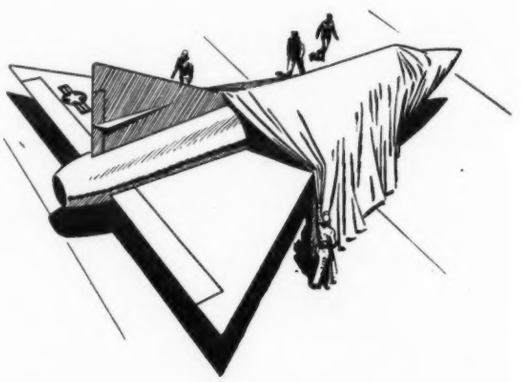
J-57 ENGINE SLATED TO POWER TWO MORE FIGHTERS

Two more advanced fighter planes, of which all details are still secret, have been added to the list of U.S. Air Force aircraft that will be powered by Pratt & Whitney Aircraft's big J-57 turbojet. These aircraft are the F-101, a long-range fighter built by the McDonnell Aircraft Corporation of St. Louis, Missouri, and the F-102, a supersonic, delta-winged interceptor built by Consolidated Vultee Aircraft Corporation. Both planes have been ordered into production.

The J-57 already powers North American's F-100 Super Sabre, the first model of which recently became the first combat airplane to exceed the speed of sound in level flight. The big, new turbojet also is installed in Boeing B-52 Stratofortress bombers, and has been selected as the power plant for several new U.S. Navy aircraft.



T-34 TURBOPROP PRODUCTION SCHEDULED

Pratt & Whitney's PT2F-1 turboprop engine, a commercial version of the military T-34, has been withdrawn from sale until a large enough market is developed to make its commercial manufacture economically feasible.

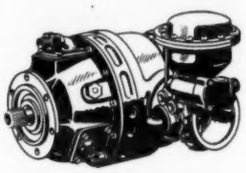
Meanwhile, in the military engine field, quantity production of the 5700-horsepower T-34 turboprop will be started soon. This engine will be installed in Lockheed, Douglas and Boeing military transports during 1954 and 1955, under Navy and Air Force contracts.

All three Pacific Coast manufacturers are modifying existing piston-engined aircraft designs for the big turboprop engine. Lockheed is building turboprop-powered Super Constellations for both the Navy and the Air Force. Douglas is building a turboprop model of the C-124 Globemaster transport for the Air Force, and Boeing is building T-34-powered Air Force C-97 transports.

HAMILTON STANDARD STARTERS EQUIP THREE NEW FIGHTERS

Hamilton Standard's small, light-weight jet engine starters are now being produced for three of the newest U.S. Air Force fighter planes, the North American F-86H Sabre, the North American F-100 Super Sabre, and the delta-winged Convair F-102.

The extreme light weight and small size of these pneumatic starters, which deliver high horsepower, contribute to overall performance of the new aircraft through lighter equipment weight and faster starting. Some models are about six times more powerful than the present electrical type of turbine engine starter. Pneumatic starters are also manufactured for three different jet bombers and two combustion-type starters are being developed.



PLANT EXPANSIONS PROGRESSING AT CHANCE VOUGHT

Expansion of facilities at Chance Vought Aircraft's big factory in Dallas, Texas, is well along toward completion. An addition to the main plant and a new structures laboratory building are almost ready for occupancy, while a large hangar building, for use in the Regulus missile program, will be finished soon.

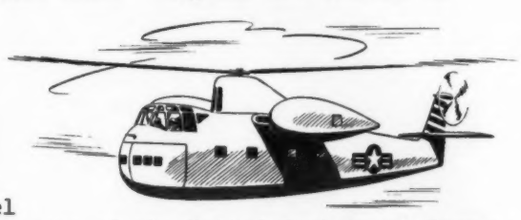
These structures are required in Chance Vought's expanded production program, which now involves the F7U-3 Cutlass jet fighter, the A2U-1 attack version of the Cutlass, and Regulus, the Navy's new surface-to-surface guided missile.

Rapidly expanding engineering work, meanwhile, has led to establishment of Chance Vought engineering offices in Boston, Massachusetts. As many as 200 engineers are anticipated for this facility, to augment the staff of 1500 men and women in Dallas.

TWIN-ENGINE SIKORSKY HELICOPTER ANNOUNCED

Production of a huge, twin-engine helicopter by Sikorsky Aircraft has been officially announced by the U.S. Marine Corps. It is designated the XHR2S. A high-ranking Marine Corps officer said the helicopter will carry two combat assault squads--about 26 combat-equipped men--and is the largest and fastest helicopter being built today.

The new aircraft is of conventional Sikorsky configuration, featuring a single, five-bladed main rotor, with an anti-torque tail rotor. Engines are located in outboard pods, into which the landing gear retracts. The machine also has large clamshell doors to facilitate loading.



Largest Sikorsky helicopter in present service with the Marines is the 10-place HRS. It is similar in size, shape and performance to the H-19 and H04S models, and to the S-55, the civilian commercial model flying passengers and freight in metropolitan areas of the United States and Europe.

Sikorsky is expected to be able to offer a commercial version of the big new helicopter in the not too distant future. It will be designated the S-56.

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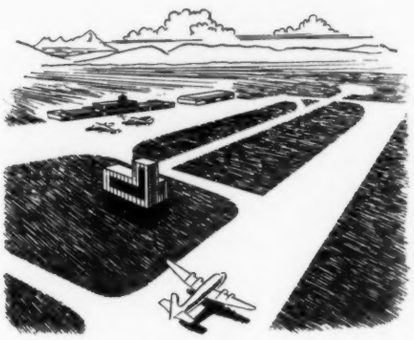

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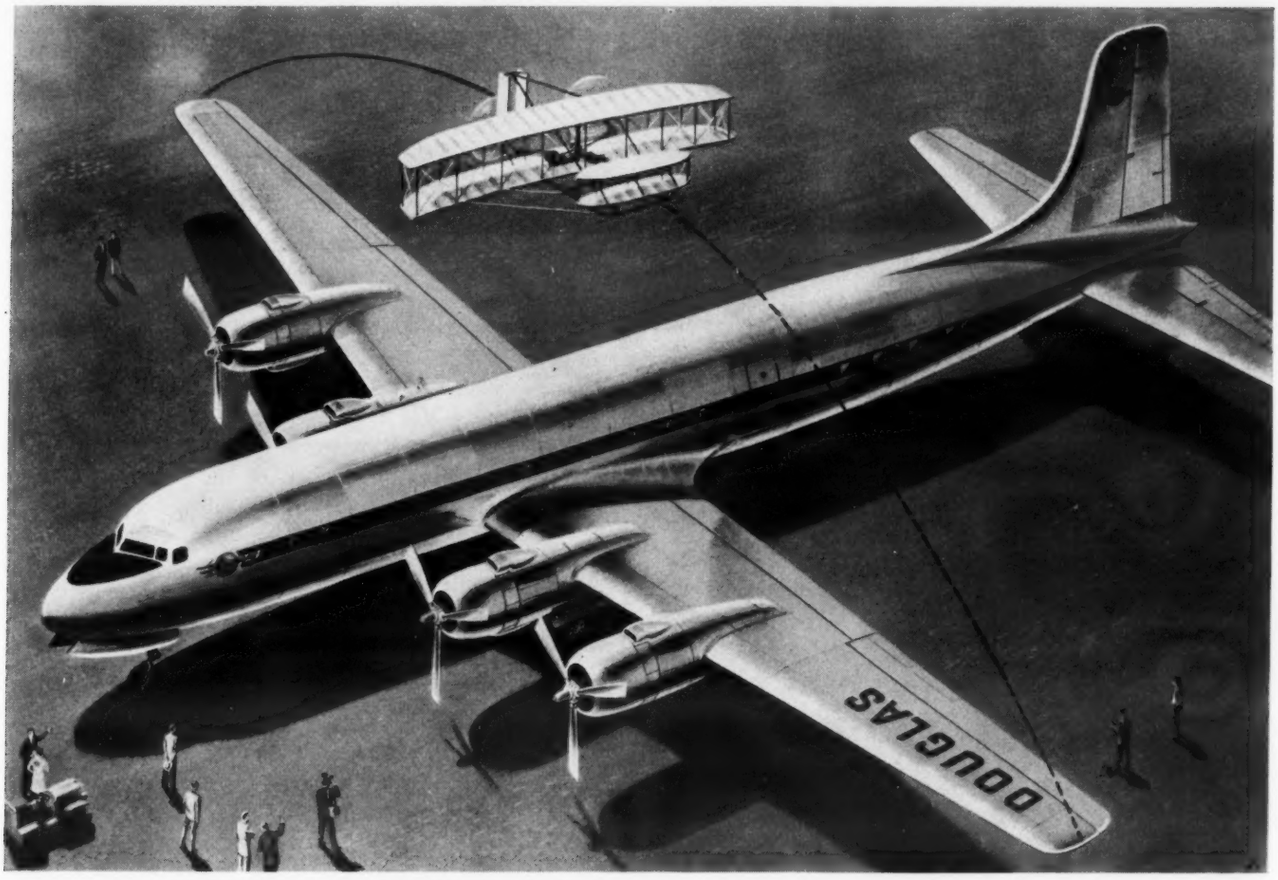
What's doing at Douglas — *WORLD'S LARGEST BUILDER OF AIRCRAFT*



"D C" MEANS DOUGLAS... builder of the famous DC-3 and DC-4... the big, modern DC-6 and DC-6B... the new DC-7. Next time, go by air! Ask for reservations on a dependable *Douglas*

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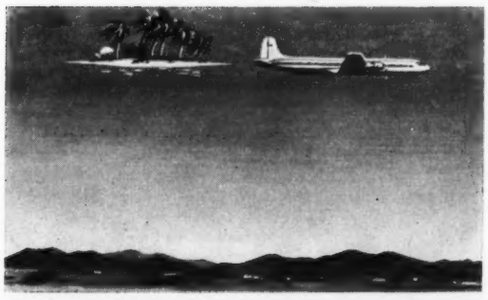

Takes the sea level up two miles! The Douglas DC-6 and DC-6B are altitude-conditioned to give you sea-level comfort 12,000 feet up. In fact, these huge airliners are built to fly almost five miles high... where the air is sunny and smooth.

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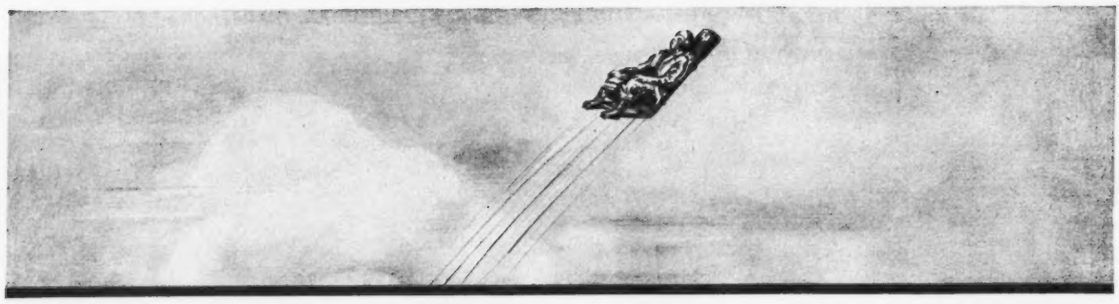

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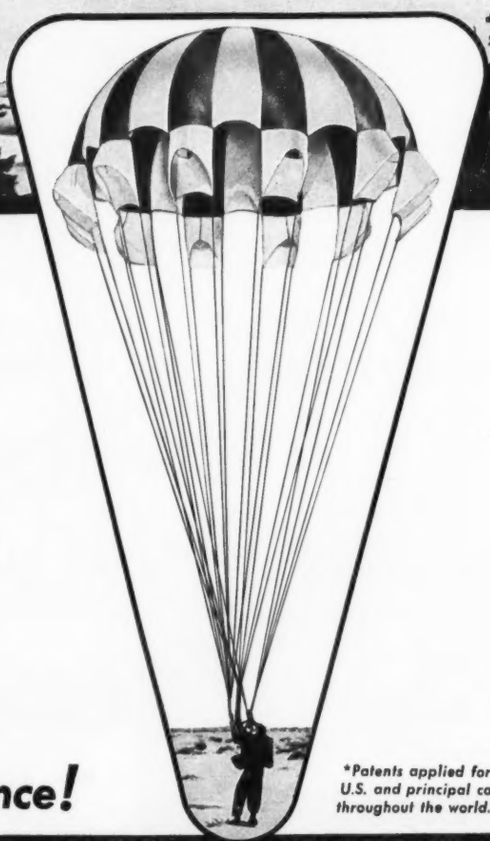

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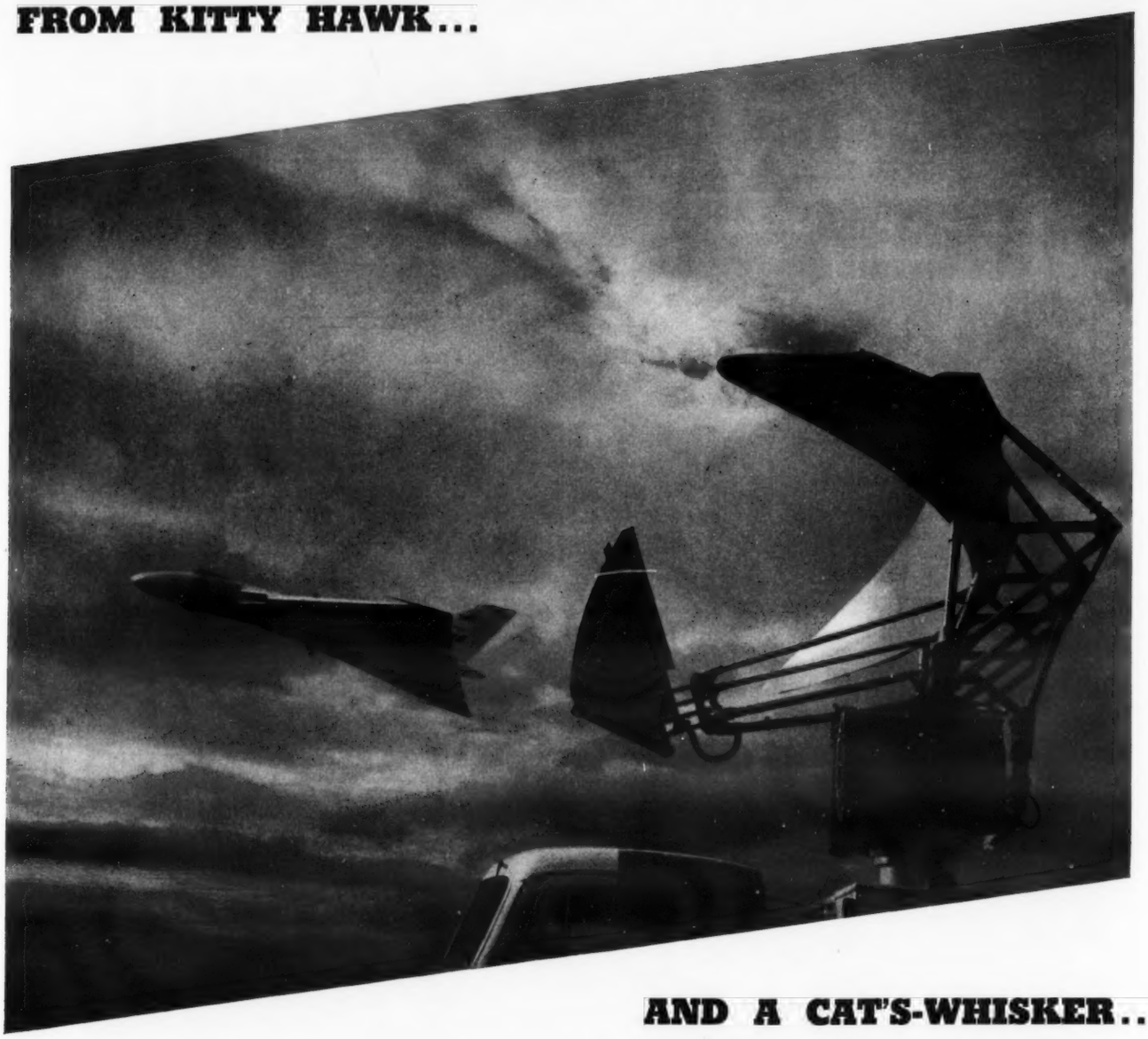

AND A CAT'S-WHISKER...

Barely fifty years separate the Vulcan from the tiny 12 H.P. biplane which, at Kitty Hawk, North Carolina, carried the first man in powered flight. An almost unbelievably short time when you think of it. Yet only a little over half that period separates catswhisker wireless from the complex radar equipment which makes the control and landing of these modern aircraft possible in any weather.

Complex did we say ? Well, considerably more complex than a crystal set but—we are talking now of the very latest radar landing aid—not nearly so complex as the equipment which was needed only a year ago. We are, in fact, talking of the Decca 424 Airfield Control radar. It was designed to land jet fighters in bad weather but it handles transport and civil aircraft equally well—and at a fraction of the cost and a good deal faster than existing equipments.

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Something New in the Air

Saab-91 Safir now a four-seater

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Like its predecessors, the 91A and the improved 91B Safir versions now in use with several air forces and government flying training schools, the 91C Safir can also be used as a primary trainer up to the more advanced stage of jet training. All this makes the new Safir one of the world's most versatile light aircraft.

A stretcher case can be easily loaded into the Safir. The new model 91C can also accommodate a medical attendant.

SAAB-91C

SAFIR

Four-seat light aircraft

SAAB

Power	one 190 h.p. Lycoming 0-435-A "flat six" aircooled engine driving a v.p. propeller.
Span	10.6 m (34 ft. 9 in.)
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Weight Empty	745 kg (1,650 lb)
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(All figures relate to 1,215 kg (2,686 lb.) weight)

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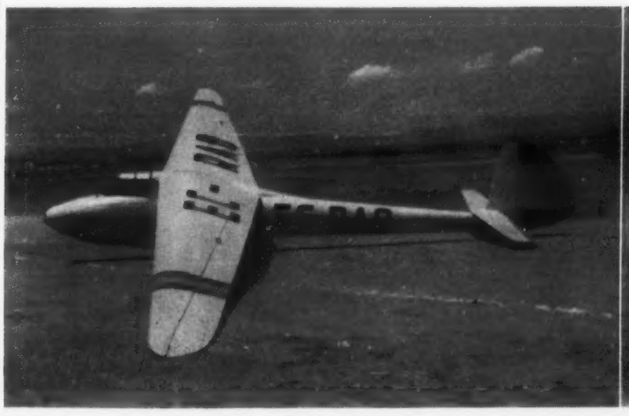
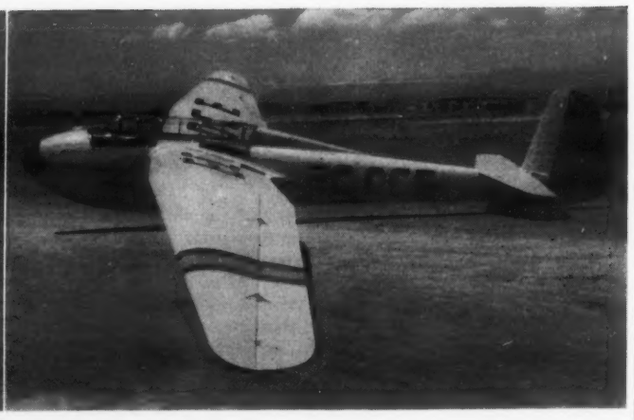


Kranich II two-seat high-performance glider.



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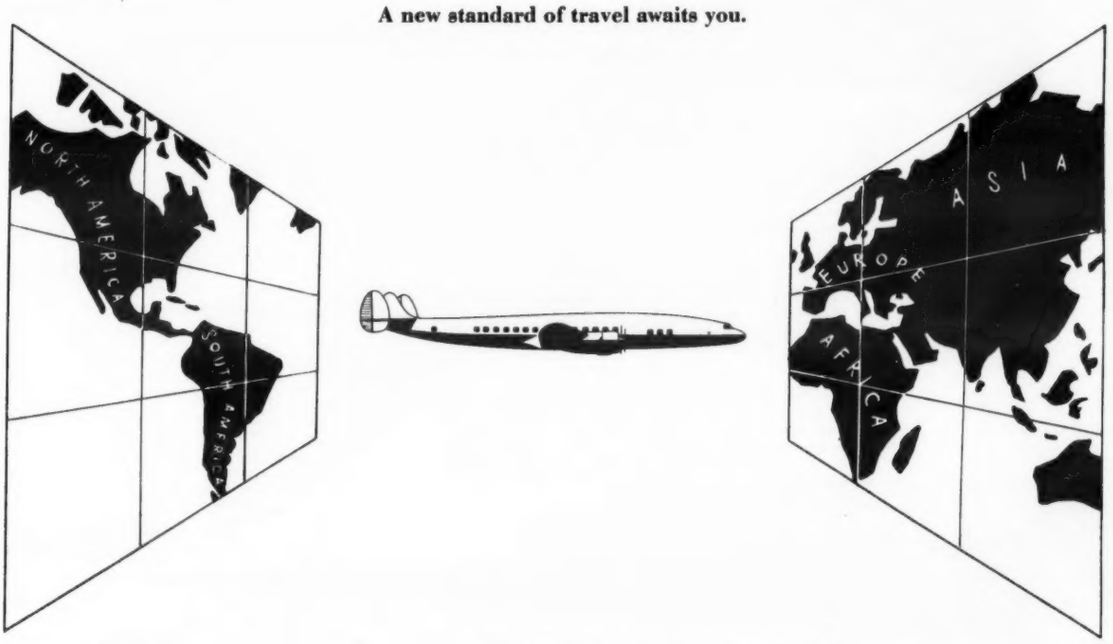

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New Comfort	**Commodious lounge - Henry Dreyfuss designed interior arrangement and styling - new meaning to "luxury aloft".**
Power	**To spare. With the newest type proven turbo-compound engines. 13,000 horsepower. Plenty of margin to go around and over the weather means on-time departure and arrival.**
All over the world	**the swing is to Super-Constellation style. 18 airlines, and more soon, have bought this plane for practical, dependable airline transportation.**
	Ordered by four times as many Airlines as nearest U.S. type. Twice as many as foreign jet types.

It costs no more to fly the best.

Lockheed

Lockheed Aircraft Corporation USA

IN THE FOREFRONT OF PROGRESS

TRUE TO ITS TRADITIONS AND DETERMINED NEVER FOR AN INSTANT TO LOSE ITS PLACE IN THE VANGUARD OF PROGRESS, AIR FRANCE IS PLACING IN SERVICE ONE OF THE MOST MODERN FOUR-ENGINED FLEETS ON THE LARGEST ROUTE NETWORK IN THE WORLD

AIR FRANCE HAS RATIONALIZED EMPLOYMENT OF ITS AIRCRAFT BY DETAILING THEM TO THE SECTORS BEST SUITED TO THEIR CHARACTERISTICS AND PERFORMANCE.

LOCKHEED "SUPER CONSTELLATION"

● The "**SUPER CONSTELLATION**", successor to the Constellation, which has made more than 50,000 Atlantic crossings, has the same outstanding qualities of reliability.
Added to these are a standard of comfort which makes of its one of the most luxurious transports ever put in service.

DE HAVILLAND "COMET"

● The "**COMET**" is the first pure jet airliner ; this means that it is no longer driven by propellers but by the ejection of the gases burned in the engine. It is an essentially fast aircraft, which enables flying times to be considerably reduced. Special features are the absence of noise in the cabin and its smoothness in flight.

VICKERS "VISCOUNT"

● The "**VISCOUNT**" is the archetype of a modern aircraft, strong and practical. A new class of aircraft, with four turboprop engines, it is fast and economical. Ideally suited for relatively short stages, it has four vital qualities : simplicity, convenience, comfort and speed.

BRÉGUET "PROVENCE"

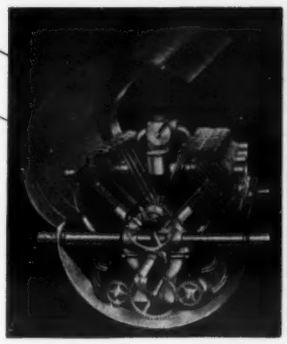
● Fast cargo aircraft, second or tourist-class long and medium range passenger transport in turn, the "**PROVENCE**" can handle the most heterogenous loads as regards shape, size and weight. Though a packhorse among transports, it is also the ideal aircraft for vacation groups, organized travel, tourist trips, family parties.

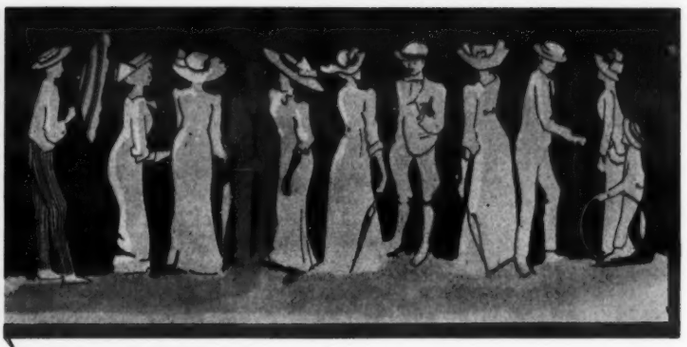
COQUERY

AIR FRANCE

Air France carries more than a million passengers a year to 220 places in 5 continents

Information : All travel agencies and Air France offices





1908

FIAT SA 8/75 Engine

FIAT AVIAZIONE

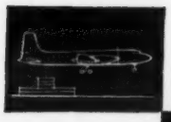
45 years of aeronautical construction

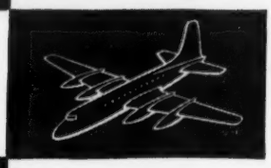
ALLISON J-35 A 29 turbojet (parts)

1953

FIAT-GHOST 48 MK 1 turbojet

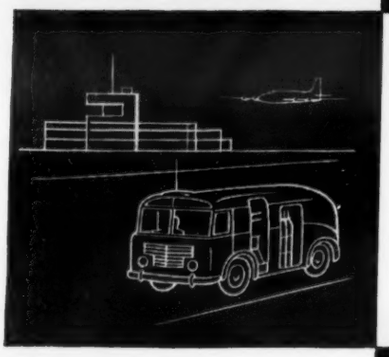
FIAT DIREZIONE AVIAZIONE Corso IV Novembre 300 **TURIN** (Italy)





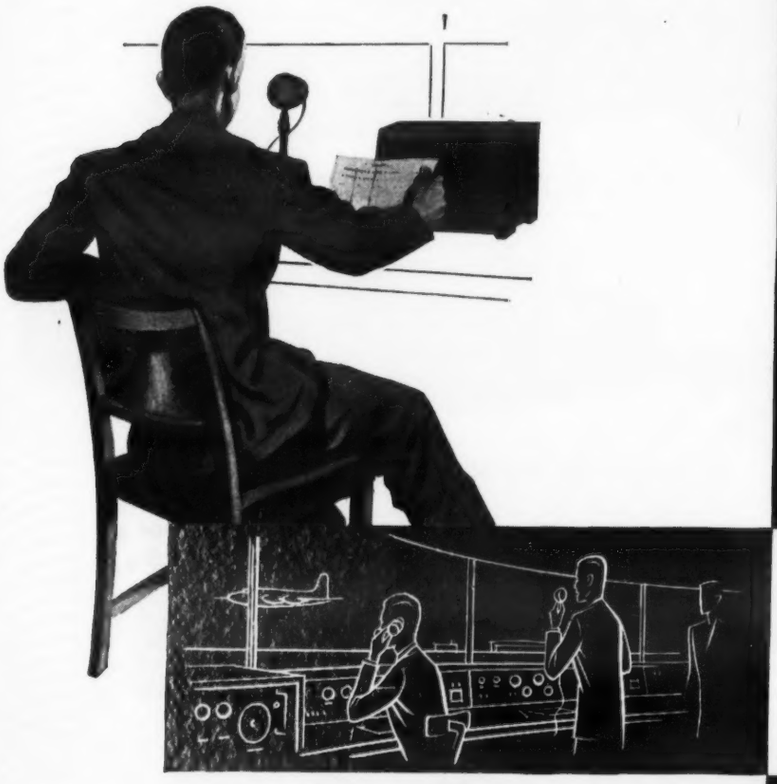
50 watt VHF TRANSMITTER

PTC 351 FOR GROUND-TO-AIR CONTROL



One of the principal applications is in the aeronautical band where the 50-watt transmitter, together with the standard Pye Fixed Receiver, provides one of the most efficient ground-to-air control stations at present available in the world.

Of an advanced design using the latest techniques, the new Pye 50-watt V.H.F. Transmitter is ideal for use in normal fixed and mobile schemes where high powered transmitters are required. It may also be used for point-to-point radio-telephone links.



The Pye 50-watt Transmitter complies with the current I.C.A.O. Regulations.

A full range of Pye Products was displayed at the S.B.A.C. Exhibition at Farnborough. Pye Engineers are available to discuss any Radio or Telecommunications problems.

Telecommunications

PYE LIMITED • CAMBRIDGE • ENGLAND

INTERAVIA

Deadline Notes

No.12, 1953

I.A.T.A.'s HONOLULU TRAFFIC CONFERENCE SUCCESSFUL

The 70 airlines represented at the International Air Transport Association's Traffic Conferences which concluded in Honolulu on November 22nd agreed unanimously on more than 30,000 rates and fares. In other words, the Conferences succeeded in only 18 days in setting up a new world-wide rate structure, which it is hoped will give air transport a turn-over of two billion dollars in 1954. Chief innovations are:

1) Tourist-class services will span the world, following agreement on tourist routes across the Pacific. - R.W. Ireland (United Air Lines), Chairman of the Conferences, stated that a round-the-world air ticket will cost $1,100 for second class and $1,700 (unchanged) for first class; 2) After 18 months' experience of tourist-class operations, all first and tourist class rates have been revised, with a slight increase being agreed to on Atlantic services: London-New York return, $720 first class, compared with $711; tourist class $520 instead of $495; 3) Free baggage limit has been set at 30 kg (66 lbs) for first class and 20 kg (44 lbs) for tourist class on all services (this has hitherto varied between 15 kg and 40 kg); 4) Agreement on seating capacity for 27 aircraft types; 5) Passenger amenities (limitation of free meals).

ATOMIC INFORMATION EXCHANGE

President Eisenhower has agreed to a plan for the exchange of information between the United States, Canada and Great Britain on the effects of atomic weapons. The operative word is "effects" ... there is as yet to be no exchange of information on design, such as the Commonwealth countries had asked for.

EUROPEAN AIR TRANSPORT CONFERENCE IN SPRING 1954

The Preparatory Committee for the Conference on the Coordination of Air Transport in Europe, convened by the International Civil Aviation Organization (members of the Committee: Belgium, Denmark, France, Holland, Great Britain, Italy, Norway, Sweden and Switzerland) has recommended that the conference be called for the spring of 1954 and should discuss the following points: 1) improvement of commercial and technical cooperation between the airlines of the countries concerned; 2) closer cooperation by the exchange of commercial rights.

U.S. NAVY ASKS FOURTH SUPER-CARRIER ...

In its 1954-55 estimates - to go before the United States Congress in January 1954 - the U.S. Navy is to ask for construction of a fourth aircraft carrier of the Forrestal class (60,000 tons).

... AND PLANS MISSILE SHIP

According to Washington reports, the U.S. Navy is considering the construction of a heavy cruiser equipped for launching guided missiles. The conversion of the two cruisers Boston and Canberra (13,600 tons) to rocket armament is to be completed by 1955.

RELATIONSHIP BETWEEN AIR FRANCE AND FRENCH GOVERNMENT

France's Minister for Public Works and Civil Aviation Paul Devinat has told the press that the change in the relationship between Air France and the French Government to a private contract (payment only for services rendered) will take place gradually from 1955 onwards. Air France's losses in last summer's strikes (1,000,000,000 francs) made it impossible to proceed more quickly. A subsidy of 1,500,000,000 francs is planned for the 1954 budget year.

INTERNATIONAL HELICOPTER SERVICES IN SCANDINAVIA

Following the example of Sabena, the Belgian airline, the Swedish charter company, Ostermans Aero A.B., plans to open an international helicopter service between Halsingborg, Sweden and Helsingör, Denmark.

* From INTERAVIA's world-wide news service, including INTERAVIA AIR LETTER, the daily international aviation news digest. — No part may be reproduced without written permission.

K. L. M. EXPECTS 9,000,000 FLORIN PROFIT

Dr. Albert Plesman, President of K. L. M. Royal Dutch Airlines, told the Commercial Club, Groningen, Holland that his company expects to record revenue of 300,000,000 florins for 1953 (259,000,000 florins the previous year) and a net profit of 9,000,000 florins (5,700,000 florins).

MIAMI DRAWS NEW YORKERS

Eastern Air Lines announces no fewer than 18 daily tourist-class services between New York and Miami, Florida, during the winter season (every hour from 8 a.m. to 1 a.m.). Since November 23rd Lockheed L-1049 Super Constellations with seats for 88 passengers have been in use. - Including E. A. L.'s first-class schedules and National Airlines' tourist-class services, the daily number of seats offered on the New York-Miami and vice versa route must be more than 5,000.

BRITISH AND FRENCH AIRCRAFT EXPORTS

British exports of flying equipment, which again exceeded £5,000,000 in September, will probably reach the value of approx. £65,000,000 for the full 1953 business year. The aircraft industry is engaging 2,000 new workers a month.

French Secretary of State for Air Louis Christiaens has announced that the French aircraft industry recorded export orders to a total value of 30,000,000,000 francs ($85,700,000) from January to October 1953. This figure is more than five times as great as for the whole of 1952.

LOCKHEED DOUBLES PROFITS AND BUILDS GUIDED MISSILES

Lockheed Aircraft Corp. report a net profit of $12,515,000 for the months January to September 1953, compared with $4,944,000 in the corresponding period last year. Order backlog on September 30th, 1953: $1,522,341,000 (September 30th, 1952: $1,098,588,000). - The Corporation is organizing a new Missiles Systems Division, under Lieutenant General Elwood Richard Quesada, the well-known radar and A-bombing expert.

*

WORKSHOP BRIEFS

Fairchild is developing a twin-jet commercial transport and cargo aircraft and a turboprop transport for military use, under a $1,500,000 research programme. * Scott Crossfield, test pilot for the National Advisory Committee for Aeronautics, has reached a speed of 1,327 m.p.h. in a Douglas D-558-2 Skyrocket. * Convair XB-58 Hustler is the full type designation of the delta-wing bomber developed by Consolidated Vultee Aircraft Corp. * Fairey Aviation is said to be working on the project for a new jet aircraft (based on the Fairey FD.1?). * A first prototype of the Folland Gnat stripped interceptor is to be ready for flight testing in the late summer of 1954. * An increase in power of the Rolls-Royce Dart turboprop (1,550 h.p. take-off power) has raised performance and gross weight for the Vickers Viscount Series 700: cruising speed goes from 311 m.p.h. to 329 m.p.h. at 20,000 ft; gross weight from 58,500 to 60,000 lbs. * SNECMA announces a new variable-section jet pipe for the ATAR 101 turbojet. Unlike other similar devices, the new SNECMA nozzle has apparently no moving parts. * The SNECMA Vulcain high-performance jet engine has axial compressor, annular combustion chamber and single-stage turbine; take-off thrust 10,000 lbs. * The twin-engined Hurel-Dubois HD 32 cargo aircraft is in the final assembly at Villacoublay; first flight before the end of the year. * Fairey Aviation Co. of Australasia Pty. Ltd. announces development of a two-seat T. Mk. 5 version of the Firefly general purpose Navy aircraft. * A new version of the Vickers-Supermarine Swift jet fighter bears the designation Swift FR. Mark 5; designed as fighter and photo reconnaissance aircraft. * Monsanto Chemical Co. has brought out a new thermosetting moulding material, known as Resinox 5700. * General Electric Co. announces a new automatic pilot, the FG.5, for supersonic aircraft, which is claimed to be 25% smaller and 35% lighter than existing equipment. * A wind tunnel for low speeds has been erected at Douglas Aircraft Co.'s Santa Monica plant; throat section 3 x 4.5 ft; projected use: for experiments with engines and ventilation plant.

* * *

Wishing all our friends and readers
a Merry Christmas and a Happy New Year

Epic Moments in Aviation

On December 17th, 1953, the newspapers of all continents and languages will commemorate the Wright Brothers because exactly fifty years ago, on December 17th, 1903, they made the first four recorded flights in an internal-combustion engine-powered aircraft. Some readers may object that theirs were not really the first flights; the Germans will point to Lilienthal, the French to Clément Ader, and with a little imagination we might even begin with Icarus. It would in fact be falsifying history and an injustice to many nations and thousands of individuals to regard the Wright Brothers—despite the magnitude of their achievement—as the sole creators of modern aviation. But that December day fifty years ago was undoubtedly one of the milestones in the history of flying. For, as Orville Wright described the flight, it was the first time that "a machine carrying a man raised itself by its own power in the air in full flight and sailed forward without reduction of speed, and finally landed at a point as high as that from which it started."

To attempt, within the compass of a single magazine issue, a description of this development, which has been pushed forward at the cost of untold mental, material and human sacrifice and can now celebrate a brilliant golden jubilee, would be presumptuous. However, our endeavour is justified by the collaboration of men who are specially qualified to write on some aspect of the vast subject, contemporaries of yesterday and witnesses of today. Who better than *Colonel Willy Coppens de Houthulst,* the Belgian flying hero of World War I and still connected with the heroic age of aviation, could pay tribute to Wilbur and Orville Wright? Where could we find anyone more qualified to write on the first half-century of heavier-than-air flying than *Charles Dollfus,* the creator and curator of the French Air Museum, with its unrivalled archives? *Gabriel Voisin,* in the true sense the first aircraft manufacturer in the world, has his own contribution to make. Top executives of Douglas and Lockheed in America, of Hawker Siddeley and Shorts in Britain compare past and present. A staff officer of international repute shows what is involved today in the creation of military aircraft.

Long before it was complete, we realized the deficiencies of our special issue. It had never been our intention to ignore the merits of the Italians, for example, and we had asked General Crocco, who is known to our readers, to contribute an article. Unfortunately, he was not able to complete it in time. Had we known that his son-in-law, Professor Giuseppe Gabrielli, Managing Director of the Fiat aircraft concern, was to speak on a subject closely resembling our own, at Turin University's *dies academicus* in November, we need have looked no further for an author. But the exploits of the Italian pioneer de Pinedo, the first formation crossing of the Atlantic by Balbo and the beginning of aero engine construction by Fiat in 1908 should not be passed over in silence. Is it not ludicrous that politics, or the so-called Iron Curtain, make it impossible to do full justice to the Russian contribution to the history of flying? Our brillant technical age is made up of seeming absurdities: German aviation history is at present only a memory or, for the Germans, a hope for the future. To take another example, Japanese flying is just about to make a new start.

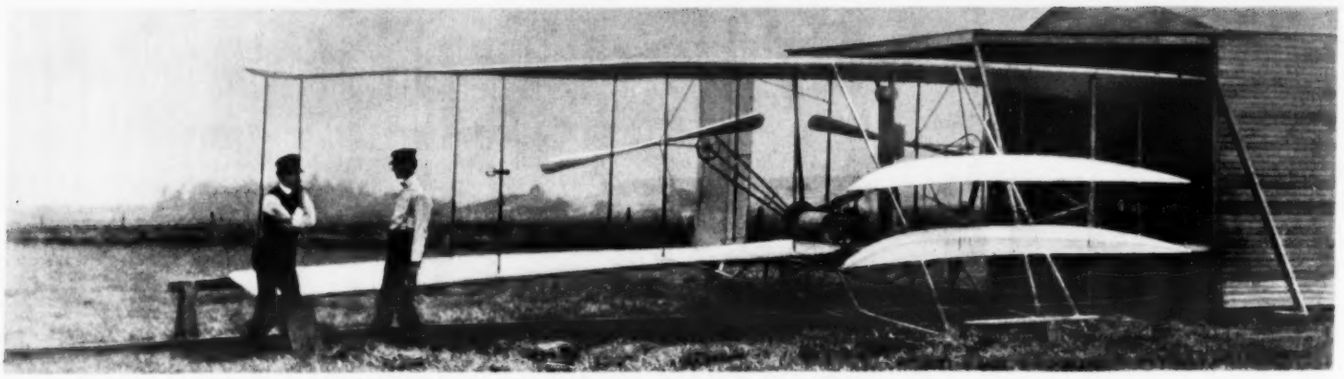
THIS IS HOW IT BEGAN . . .
Orville Wright on his way to a flight . . . fuel in hand.

What are the facts? The Wright Brothers undoubtedly stood godfather to later developments. Charles Lindbergh undeniably opened up a world transport route. Whether Whittle in Britain, Campini in Italy or Heinkel in Germany made the first jet aircraft we are not competent to decide. We do not feel justified in passing over the Atlantic flight by the two Frenchmen, Costes and Bellonte, simply because Lindbergh's name overshadows all others. The achievement of the men who have contributed to this first half century would fill volumes.

Let us be plain: "Fifty Years of Powered Flight" are not the sole merit of two enterprising and courageous men . . . They are the common property of all civilized nations, as the helicopter of today exemplifies. The Frenchman Bréguet, the Russo-American Sikorsky, the Spaniard de la Cierva and the German Focke all had to make their contribution before our contemporaries Piasecki and Hiller—to name but two—could turn out helicopters in quantity.

The feats of these fifty years, which have culminated in supersonic flight, flight to the upper limits of the stratosphere and a revolution in strategy and transport, are a living proof of the indivisibility of the world. And as every individual and every community has its epic moment, so the history of flying in this half century is composed of a succession of epic moments.

E. E. H.



The Wright Brothers putting the finishing touches to the world's first successful powered heavier-than-air aircraft. Span: 40 ft. 4 in. Wing area: 510 sq. ft. Empty weight: 600 lbs. Gross weight: 750 lbs.

The Birth of Flying

The Wright Brothers

BY

COLONEL WILLY COPPENS DE HOUTHULST

Orville and Wilbur Wright in 1903.

Colonel Coppens de Houthulst, Belgium's foremost air ace of the 1914—1918 war served as Air Attaché to the Belgian Embassies in London, Paris and Rome between the wars. Since his retirement from the Service he has placed his pen at the disposal of aeronautics. While his books and papers have often been critical studies of certain aspects of aviation, he has also written reminiscences and historical essays on the conquest of the air. To mark the golden anniversary of the first powered flight by the Wright Brothers, INTERAVIA *is happy to publish one of these essays, the details of which are based mainly on John R. McMahon's biography, "The Wright Brothers, Fathers of Flight." Ed.-*

On December 17th, fifty years will have passed since a man, piloting a winged flying machine, rose from the ground in the manner of a bird and thus succeeded in making the first flight to be accomplished by purely mechanical means.

The event took place at a practically deserted spot on the East Coast of the United States, and the heroes of the adventure–the machine was conceived and built by two brothers who contributed an equal share to their accomplishment–owed this success to the foresight with which they had conducted their methodical and persevering work.

Their successful flight, crowning a long series of earlier attempts, was preceded by the dreams and speculations of numberless experimenters. The Wright Brothers had started their work at the most propitious moment, for the type of engine which enabled their aircraft to take off had made its appearance a few years before. At the same time, they knew how to make use of and adapt to their own purposes all the research work that had gone before them. Their imagination was seconded by a critical sense of analysis.

The kite had existed since time immemorial. Up to a point it could serve as a model for the aeroplane. The Wrights studied it and used it to test the principle of stability they had evolved, to settle their ideas and to accomplish a feat of practical reality.

Calculations and laboratory tests had guided the first steps of other inventors. The Wrights used them to perfect their methods and correct their mistakes.

Above all, they discovered how to pilot their machine even before it was ready to carry them aloft under its own power.

It would not have been possible to proceed more logically, to achieve success more rapidly —one might even say, more inevitably.

We do not doubt the genius of Clément Ader, nor the success he achieved in 1890 and after by lifting a few inches from the ground a heavier-than-air machine whose engines and wings were entirely of his own design. But the aircraft's first experiment was also the first the pilot had made and in addition he was hampered by a committee of military experts. In these circumstances a more complete success could not have been anticipated from a first attempt. And the report submitted to the War Ministry cut short the endeavours of an engineer who, perhaps, had visualised the beginnings on too grand a scale and therefore needed the assistance of the French Government. This help was quickly withdrawn, and the first experiment was not followed up.

The first practical flight meriting the term therefore formed the culmination of the experiments carried out by two men working alone, independently of all the others—and with uncommon intelligence.

The father of Wilbur and Orville Wright was Milton Wright, Bishop of the United Brethren church and publisher of the *Religious Telescope* of Dayton, Ohio. It was at Dayton that Orville was born on August 19th, 1871, and it was there that Wilbur died in 1912. It was there, too, that the two brothers' aeroplane was conceived and created.

When Wilbur was eleven and Orville seven, their father brought them a small toy helicopter, the invention of Alphonse Pénaud, which fascinated them. The seed was sown, and it germinated because it had fallen on fertile soil.

By 1892 the two brothers owned a bicycle repair shop, and four years later they were selling their own cycles, which they assembled from manufactured parts.

America learned of Lilienthal's death in 1896. He had been killed in Brandenburg in the course of his two thousandth flight in a glider he had designed himself. The news of his death induced the Wright Brothers to read the book on "Animal Mechanisms" by the Frenchman Etienne Jules Marey—and from that moment onwards the problem of flight preoccupied them constantly.

They began by studying the question of stability, and as early as 1899, Wilbur conceived the idea of wing warping. To test his design he built a small model in the form of a box kite. This was followed up by the Wrights' first glider.

They then began to look about for a locality with steady prevailing winds, hills to enable them to take off and stretches of sand to soften their landings. The Meteorological Bureau in Washington indicated Kitty Hawk, North Carolina, where they found a long, sandy beach on the Atlantic to test their glider.

Although they could see a dozen houses from their camp, the spot was as secluded as they wanted it to be.

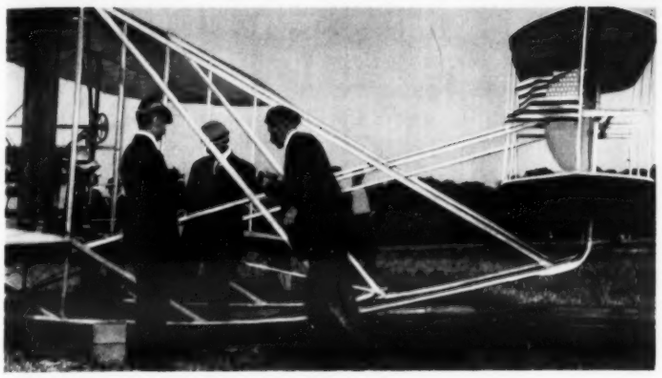
Prior to equipping their glider with control surfaces, the Wright Brothers flew it like a kite, first without a pilot, later with Wilbur and then Orville extended in a prone position on the lower surface of the biplane structure.

They then mounted the elevator control, and in September and October of 1900 they completed several gliding flights.

The following year, in the presence of their friend and rival, Octave Chanute, the Wright Brothers flew a new glider over a distance of 389 feet against a headwind of 37 miles per hour. They were not satisfied, however, because their machine was not docile and efficient enough.

Back at Dayton, they designed the wind tunnel which enabled them to study the effect of the air flow on the surfaces of a scale model placed in an artificial air stream. They tested more than two hundred wing models, monoplanes and biplanes and discovered that wings and struts must be profiled, with the blunt edge facing into the wind and the thin edge away from it.

The summer of 1902 saw them back at Kitty Hawk. The new glider they took with them had a span of 32 feet and a wing surface of 305 square feet.



Kitty Hawk: Wilbur and Orville checking the struts of their aircraft.

Charles Taylor, the Dayton mechanic who built the original engine for the Wrights' first powered aircraft, points to the ignition camshaft of the 1953 replica engine. Engine power: 16 h. p. at 1,200 r. p. m. Fuel capacity: 3 pints.

Taking turns, Wilbur and Orville resumed their gliding experiments starting into the wind from a sand dune known as Kill Devil Hill which rose 200 feet above the landing area. On several occasions they covered more than 600 feet. Their longest glide lasted 43 seconds.

Before they even left Kitty Hawk, they began to design a powered aeroplane and considered applying for patents to cover their inventions.

Upon their return to Dayton they built the engine they needed. They tested it on February 12th, 1903. Carefully they adjusted and perfected it until it ran satisfactorily. It delivered 16 horse power.

On September 23rd they went back to their dunes. Wishing to rise from the ground without help from any unevenness of the surface, they placed their machine on a long wooden rail.

Difficulties encountered in preparing their machine for flight delayed the decisive attempt. On December 17th the aeroplane was ready to go. It was placed facing into the wind, and the engine was started up. Five spectators were watching the experiment—the entire population of the neighbouring hamlet.

At 10.35 hrs. the machine began to slide along the rail under its own power. After covering forty feet it left the rail, rising to eight or ten feet above the ground. Orville, the pilot, maintained it as level as the gusts of wind permitted. After twelve seconds and covering one hundred and twenty feet in the air the aircraft landed. The Wrights had completed the first powered flight.

A second attempt was made at 11.20 hours. Wilbur flew a distance of 175 feet. Twenty minutes later Orville reached the same distance, but this time he rose to a height of 14 feet.

At midday Wilbur set out on the fourth and last flight. Rising in the violent December wind, he struggled along for 300 or 400 feet and then succeeded in maintaining a horizontal position . . . He stayed in the air for 59 seconds and landed normally 852 feet from the end of the wooden rail. His ground speed—against the headwind—therefore was 31 m. p. h.

The news of the Wright Brothers' successful flights was received with scepticism and aroused little interest at the time. But the two inventors had tangible proof of their own capabilities.

By April, 1904, the two brothers had completed a new aeroplane with a slightly more powerful engine. They tested it in a cow pasture near Dayton.

For two years, Dayton and the world paid scant attention to their experiments, however convincing the results. There were several reasons for this attitude: whenever the public and the press are informed of a development, they demand an immediate, striking demonstration. What they will see after the event will scarcely interest them. And the Wright Brothers failed during their public demonstration. In their first attempt the wind was not strong enough to lift the machine off the ground before it reached the end of the rail. In the second, the engine did not function properly.

Another reason was that the Wright Brothers, cautious as ever always flew very low in order not to increase the danger of damage or injury: flying over a cow in their field for instance, was quite an event. This kind of "hedgehopping" obviously did not fire the popular imagination in that remote corner of Ohio.

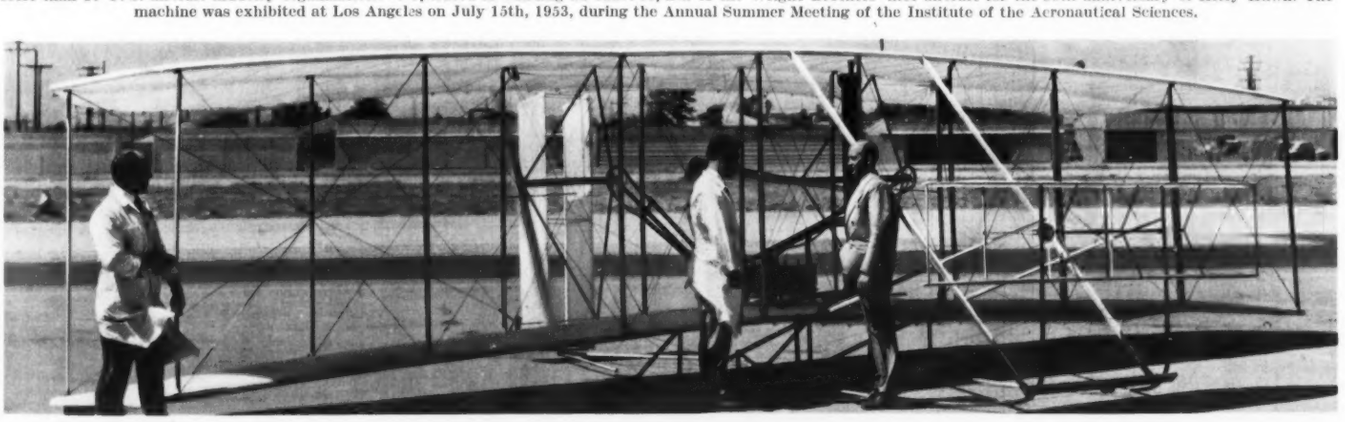
Furthermore, the Wrights made no attempt at showmanship. Four years in succession they had gone to their desolate sand dunes at Kitty Hawk on the Atlantic Coast, but they never even thought of travelling to New York, Washington, Pittsburgh or Chicago, all of which were much closer, or even nearby Cincinnati. They waited for the world to come to them, and their contacts with the world beyond Dayton were rare and intermittent.

It was not until France–a country where men had faith in the possibility of human flight–took an interest in the work of the Wright Brothers that recognition of their pioneering achievement became widespread. This was at Le Mans in August, 1908, when Wilbur Wright made his first demonstration flight in France. But, although the Wright biplane immediately proved to have better manœuvrability than other aeroplanes then in existence, it obviously had lost some of the value it had possessed four years earlier, in 1904, when it was the only aeroplane in the world.

The two brothers remained sceptical for several years of the claims put forward by other aircraft constructors. It was only after the series of successes which rapidly followed the historic flight of Santos-Dumont, who on November 12th, 1906, took off from the lawn at Bagatelle and covered a distance of 720 feet, that the Wright Brothers began to worry about competition.

It was then that they signed their agreement with the Paris *Journal*, whose representative had been negotiating with them at Dayton since December, 1905.

More than 20 U. S. aircraft industry organizations co-operated in building an exact replica of the Wright Brothers' first aircraft for the 50th anniversary of Kitty Hawk. The machine was exhibited at Los Angeles on July 15th, 1953, during the Annual Summer Meeting of the Institute of the Aeronautical Sciences.



Men have been Flying for Fifty Years

BY CHARLES DOLLFUS

Charles Dollfus.

France—where the first Montgolfier balloon ascent was made at the end of the 18th century, in whose workshops "obscure bicycle mechanics" put together the first practicable aero engine early in the 20th century—was perhaps more qualified than any other country to keep the diary of human flight. Small wonder that the Paris Musée de l'Air *contains many a unique exhibit. Interavia is glad to report that Charles Dollfus, founder and Curator of this museum, has consented to lead its readers through his treasure house. An eye-witness of pioneering events, and frequently a participant, he has continued to maintain close contact with aviation circles throughout the world. In 1932 he collaborated with Henry Bouché—at one time France's leading aviation writer and today his government's representative on the I.C.A.O. Council in Montreal—on the great illustrated history of aviation published by "Illustration", a standard work in the world's aviation literature. Over to Charles Dollfus . . .*

"The Great Year of 1903" was the title of one of the sections of the Air Museum stand at the Paris Air Show this year. Models and documents explained and justified this title. Within six weeks in that historic year, the two paramount events in aviation had taken place, one in France, the other in the United States.

On November 12th, 1903 the Lebaudy dirigible, manned by pilot Georges Juchmès and mechanic Antoine Rey, took off from Moisson near Mantes, and landed on the Champ-de-Mars in the heart of Paris, after covering a distance of 38 miles. This was incontestibly the *first controlled air voyage.* The fact has never been sufficiently appreciated, and there is no monument on the Champ-de-Mars to mark the successful end of the journey. Pilots of airships regard the performance as all the more outstanding since Juchmès had no elevator control and thus had to manœuvre solely with the aid of ballast and valves. The Lebaudy's steel body, as strong as a warship, is one of the most valued exhibits in the Air Museum.

Before this time, Renard and Krebs had demonstrated as early as 1884, that it was possible to return to the point of departure. In 1901 Santos-Dumont had confirmed that balloons could be controlled. He did this by covering fixed circuits in a given time, and in the same year of 1903 he had used his small dirigible No. 9 for trips between Bagatelle, Longchamp and Paris. But the Lebaudy was undeniably the first powered flying machine to cover any considerable distance and make a real voyage.

Exactly six weeks later, Wilbur and Orville Wright, the two most outstanding figures in the history of heavier-than-air flying, completed *their first four powered flights.* Three of them, made alternately by Orville and Wilbur, lasted 12 to 15 seconds, an appreciable performance at the time, and the fourth, by Wilbur, lasted 59 seconds and covered a distance of 284 yards. Contrary to many assertions since that time, take-offs were made from flat ground, solely with the aid of equipment carried in the aircraft and without any external assistance. A launching catapult was not used by the Wright Brothers until their second series of flights in 1904. Moreover, the 1903 machine was entirely under their control and kept headed into the wind by the action of the rudder in conjunction with the warping of the wings.

Orville Wright, with whom I had the rare good fortune of spending several hours in his Dayton laboratory, told me that the brothers' feelings were not of delirious joy but merely of great satisfaction, because they knew that this was the normal result of their work. They would have been much more astonished not to have succeeded, since they had gathered together all the necessary elements, suitable wing, satisfactory propellers, adequate power for its weight, stability and manœuvrability and, what is more, the certitude that they knew how to fly. Success could not elude them, as they were to prove during the years that followed.

It is difficult to assess the value of their perseverance, the methodical development of their techniques, in both design and construction, their careful training on hundreds of unpowered flights, all of this carried out simply and solely with their own resources.

Homage must also be paid to the man who advised and guided them, without, however, imposing on them his own ideas. This was Octave Chanute, an American of French birth, who took a passionate and altruistic interest in their work and had himself invented, in 1896, the biplane wing unit which has been in almost universal use up to the present day.

We must also do justice, as did the Wright Brothers themselves, to the inspiration they received from Mouillard and his studies of the flight of birds; from Lilienthal for the experimental method which led them to victory and for his scientific work; from Langley whose technical papers gave them some of their training, and finally from James Means, a Boston aviation enthusiast, virtually unknown today, who between 1895 and 1897 published three *Aeronautical Annals,* in which he collected to-

November 12th, 1903: Just over a month before the first powered flight by an aeroplane the dirigible *Lebaudy* (pilot Georges Juchmès, mechanic Antoine Rey) flew 38 miles from Moisson to Paris.

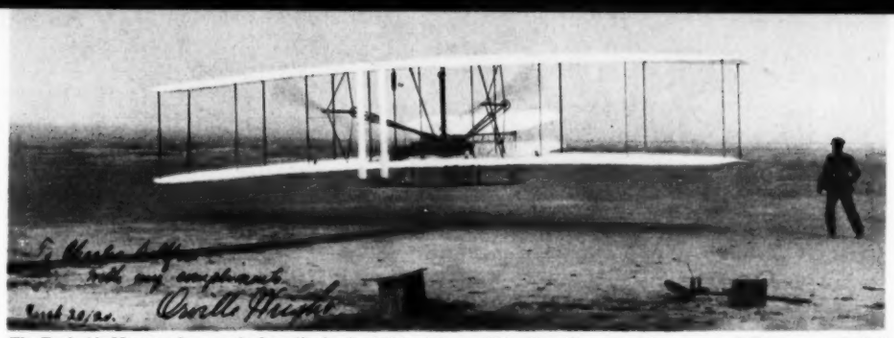
gether all the fundamental knowledge then available on flying, and who was also one of the inspirers of Hargrave.

In October and December, 1903, still during the historic six weeks, there came the experiments with a large aeroplane, Samuel Pierpont Langley's tandem-winged "Aerodrome". The machine, the result of very long theoretical research and practical experiments on large models with steam or petrol engines which flew more than 1,640 yards, was the first aircraft fitted with a petrol engine specially designed for flying. This 52 h. p. engine with five radial cylinders was a remarkable construction and is today preserved alongside Langley's aircraft at the Smithsonian Institution in Washington.

Though the machine and its engine had been worked out with meticulous care, Langley's experimental methods led to a doubly unfortunate setback. On the one hand, engineer-pilot Manly had absolutely no flying training, on the other the aircraft, of very frail construction, had no means of landing or alighting and had to be launched very roughly by a catapult placed on the top of a houseboat in the middle of the Potomac River.

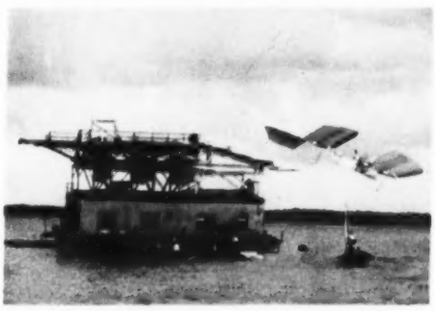
On October 7th, 1903, the big machine was launched and immediately descended into the water; on December 8th, the "Aerodrome", which had meanwhile been repaired, was catapulted again and toppled over the edge of the houseboat into the river, being wrecked in the process. Manly escaped on both occasions without harm, but the U. S. Government, which was subsidising Manly's experiments, refused to pursue them further.

1903 in France: Capitaine Ferber, one of France's most untiring aviation pioneers, testing his apparatus for powered kites.



The Paris Air Museum has marked on the back of this picture: "Handle with care, only copy . . ." *First powered flight by the Wright Brothers* at Kitty Hawk on December 17th, 1903 (autographed by Orville Wright for the author).

In 1904 and 1905 the Wright Brothers continued their experiments, this time at Dayton, with a biplane similar to the one used at Kitty Hawk but with a more powerful engine. They made no fewer than 105 flights in 1904, including a turn and closed circuit on September 20th. By this date, flying was an accomplished fact.



An unsuccessful attempt of 1903: Professor Langley's "Aerodrom" piloted by Manly toppled into the Potomac on taking off.

Contrary to what has often been said, it was not until this period that the Wright Brothers designed and used a catapult with a weight falling inside a pylon, to facilitate take-off in calm weather.

During the fifty flights made by Wilbur and Orville Wright in 1905 they reached an endurance of 38 minutes on a circuit of 22 miles.

The fact that the Wright Brothers enjoyed complete success without ever having any serious accident even to their equipment is due to their scientific mentality, their rational methods and their infallible judgment, no less than to their courage and their tireless energy and perseverance [1].

The pioneers of flying who recently had the honour of visiting the sand dunes of Kill Devil Hill and Kitty Hawk gained a new appreciation of the work of these two inventors. In those days, the region was an almost desolate tongue of land, with no drinking water, and no means of access, but it had the type of ground and the constant winds they required. Here they built a shed, brought their successive machines and tried them out, several hundred miles from their home in Dayton, where they left behind their modest bicycle business.

An astounding fact is that Langley's experiments and, even more, the Wright Brothers' successes passed almost unnoticed in the United States. The few reports which did appear were confused with the accounts of doubtful experiments issued by unreliable persons, such as Gustave Whitehead and with the exploits of the dirigibles, which both journalists and public failed to distinguish from heavier-than-air flying machines.

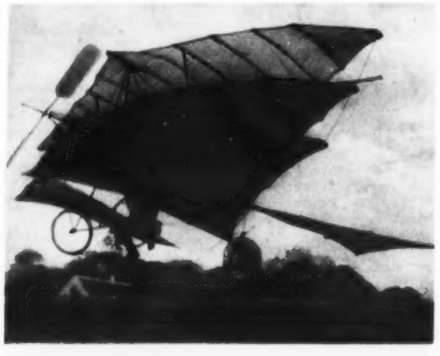
Aviation circles in Britain and Germany received the news with rather more interest, but it was in France that the Wright Brothers' flight really aroused enthusiasm.

France was doubly prepared: free balloon contests, the stir caused by Santos-Dumont's and Lebaudy's dirigibles had prepared men's minds for air navigation. A flying movement had already been sketched out, and on May 9th, 1903, the Aero Club of France had formed a

[1] But five years after the first flights Orville Wright suffered a serious accident (September 17th, 1908), the first fatal accident in aviation history, in which Thomas E. Selfridge of the U.S. Army Signals Corps lost his life.

January 13th, 1908: Henri Farman flew 1 km, returning to his starting point, and won the Deutsch-Archdeacon Prize (25,000 francs).

September 1906: Scandianavia enters the contest: first flight by the Dane J. C. H. Ellehammer in his extraordinary looking triplane . . . which actually flew 45 yards.



Horses frightened by their new competitor: in August 1908 Wilbur Wright demonstrated his flying machine in France.

sub-committee for flying experiments presided over by Colonel Renard, with Ernest Archdeacon as the moving spirit. Captain Ferber, an exceptionally enthusiastic pioneer, had emulated in public the experiments of Lilienthal and the Wright Brothers.

Finally, in May 1903, Chanute had read a striking lecture to the Aero Club on his gliders and those of the Wrights, the text of which appeared in the *Aerophile* with precise hitherto unpublished drawings. The 1903 flights were publicized and discussed in detail, with some doubting and other accepting the truth of the reports. Renard, Ferber and Archdeacon regarded them as particularly important.

Ferber was appointed to the military establishment of Chalais–Meudon where Colonel Renard had opened a laboratory for aeronautical research. Here two young non-commissioned officers, Louis Paulhan and Louis Peyret, were building models that were as varied as they were interesting.

1909: the first rational aircraft engine, the Séguin Brothers' 50 h. p. Gnôme.

July 4th, 1908: Glenn Curtiss's *June Bug* in flight.

Esnault-Pelterie also repeated the Wrights' exploits in 1903 and 1904, while Archdeacon had a Wright-type biplane built which made "air glides" at Berck in 1904 piloted by a young engineer, Gabriel Voisin. Others, such as Lavavasseur, Robert and Solirène had tried out aeroplanes.

In February, 1905, the Aero Club of France organized a flying contest which lasted three days. This was primarily a presentation of models, but those who, like the writer, had the good fortune to attend were deeply impressed by the event.

Finally, the Government sent Major Bonnel to see the Wright Brothers with an offer to buy their invention. The negotiations failed, unfortunately, but the attempt was to the honour of France, since the Wrights' offers to the Washington Government had been categorically turned down.

The year 1906 was to see flying take a new turn. In France, Vuia, a native of Transylvania, tried out an aeroplane of his own design, with a carbonic acid engine. Several ascents were made at Montesson in March 1906 and several more at Bagatelle on August 19th.

In Denmark an inventor named Ellehammer also succeeded in leaving the ground for about forty yards, on September 12th.

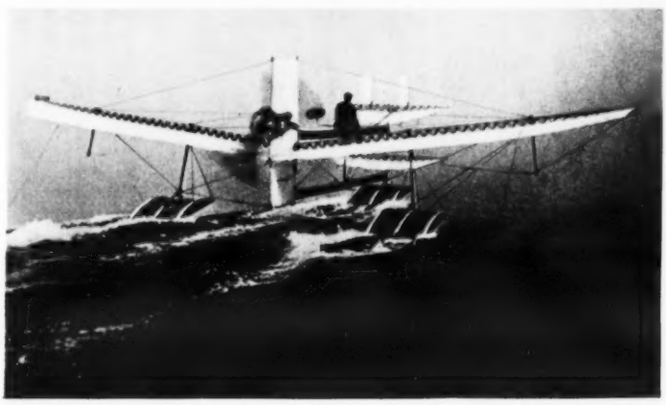
Buth the real triumph was that of Santos Dumont, a recent convert to heavier-than-air flying. Having fully studied the work of the Wright Brothers during his visit to the United States in 1904, Santos-Dumont was convinced of the possibilities of the aeroplane. The machine he himself built was very different from that of the great Americans. Taking over from Voisin the cellular-wing biplane arrangement, which the latter had fitted to the biplane built for Blériot, Santos-Dumont constructed a biplane without a tail, of the "canard" type, i. e. with combined control surfaces in the nose of a long fuselage. The wings had a pronounced dihedral, to provide stability. The *Antoinette*

1908: The American Glenn Curtiss at the controls of his *June Bug*.

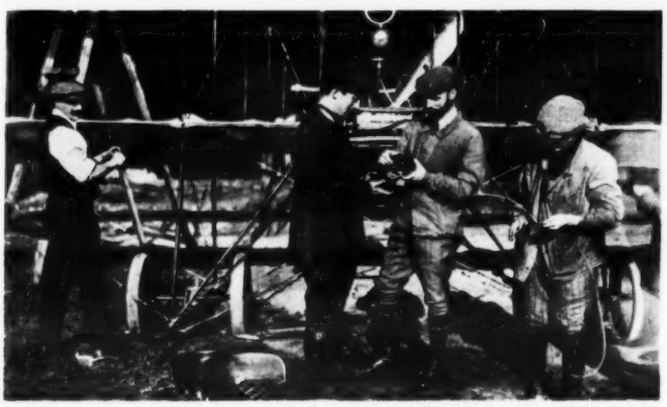
1909: the aeroplane ventures across the sea. Louis Blériot, the conqueror of the English Channel.

July 25th, 1909: Blériot's Type XI monoplane (25 h. p. Anzani engine) before taking off across the Channel.

First air meeting – the last word in fashion and in flying. King Gustav of Sweden and his family at the Nice meeting.



March 28th, 1910: the first seaplane, Henri Fabre's "canard", taking off from the Etang de Berre near Marseilles.



1910: First flight over more than 100 km. A Farman biplane flown by Louis Paulhan (in fur cap) started off at night on the 178 km. run from London to Manchester. Right (with cigarette) Henri Farman.

engine, first of 24, then of 50 h. p. was a real aero engine, and drove a pusher propeller.

The machine was taken from Neuilly to the Bagatelle field. Santos-Dumont made methodical training experiments using a long cable, to get accustomed to the controls. His experience of the air, manual dexterity and calm judgment brought him success.

On September 13th he covered about 13 yards; on October 23rd he made a first flight of 65 yards, in the presence of a number of enthusiastics. Finally, on November 12th he took off over a distance of 240 yards, reaching a height of 15 to 20 feet and remaining in the air for 21 seconds. These flights were officially measured and made before a large public.

They aroused considerable attention because the public was well prepared for the idea of flying and because of the personality of Santos-Dumont. Obviously these very short flights, during which neither directional control nor stability were obtained, were not the sort of flying which the Wright Brothers had achieved, but they were undeniably the beginning of serious practical flying.

Experiments then succeeded each other at a tremendous rate in France, which had a considerable advance over Great Britain, Germany and the United States, except for the Wrights. Blériot, Voisin and Delagrange, Esnault-Pelterie, de Pischof, then Henri Farman, had all flown less than a year after Santos-Dumont, who himself was trying out a minute monoplane, the *Demoiselle*.

The essential facts are the following: after making a tumultuous flight of 200 yards in a tandem monoplane, Louis Blériot built and tested a machine which is the real forefather of all modern aircraft, a low-wing monoplane, with metal tractor propeller, three-wheel undercarriage, rear control surfaces, completely enclosed fuselage. The only difference was that the ailerons were formed by the two elevators, which could be operated differentially. A few days later, Esnault-Pelterie took off in a monoplane with a tractor propeller, which is also one of the precursors of modern aircraft.

Henri Farman was the first in Europe to understand and demonstrate how to fly rationally in an aeroplane. His Voisin biplane had no lateral stability controls, and turns vere rendered even more difficult by the large cellular tail.

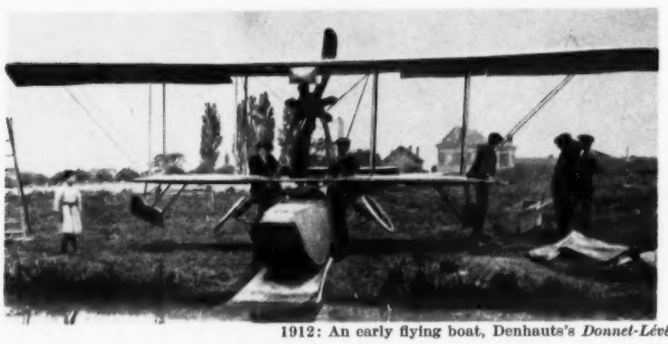
A flight of 842 yards at Issy-les-Moulineaux on October 26th, 1907, was the prelude to his triumph of January 13th, 1908, when he won the Deutsch-Archdeacon prize over a one-kilometre closed circuit. As the Wright Brothers' experiments were so little known, this feat was hailed as something quite new.

Henri Farman also took up the first passenger

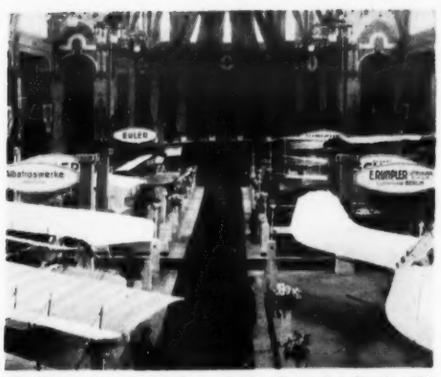
Flying at Issy-les-Moulineaux in 1910.

Farnborough . . . in 1910: The American Samuel F. Cody's *Cathedral* biplane being towed into take-off position by an artillery ammunition cart.

November 1913: Another can of fuel please! The Nieuport in which Emmanuel Helen won the Michelin Prize (for longest distance covered).



1912: An early flying boat, Denhauts's *Donnet-Lévêque* at Juvisy (originally designed as an amphibian).

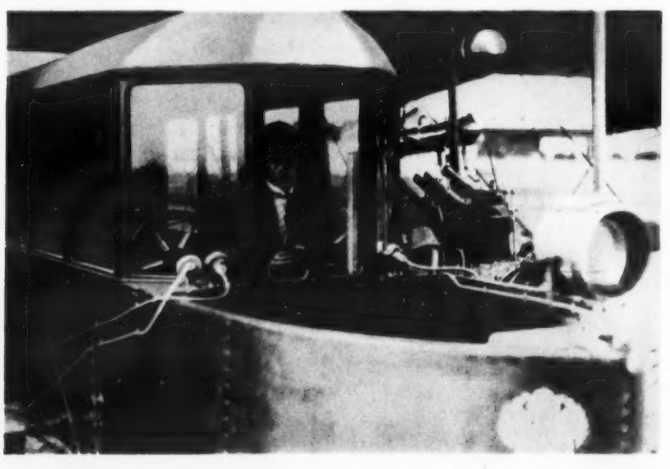


Berlin air show in 1912 . . . right a Rumpler *Taube* with cabin.

Maurice Prévost first to fly more than 200 km; winner of Gordon-Bennett Race (September 29th, 1913).

"Mass transport in 1911": Louis Bréguet carried ten passengers on March 23rd, 1911 and set up a record for largest number of passengers (not exactly heavy-weights, though).

1913 . . . year of records: First acrobatic flights by Pégoud; Roland Garros made the first Mediterranean crossing, and Sikorsky demonstrated the first cabin multi-engined aircraft at Kiev. Left, Roland Garros after landing at Bizerta; right, Sikorsky in the cockpit of the four-engined *Bolche*.



to be carried in an aeroplane, at Ghent on May 30th, 1908. The passenger was Ernest Archdeacon, the man who had most deserved the honour through his unfailing confidence.

But the essential historic fact in the career of Henri Farman is his first air voyage in an aeroplane, from Bouy (Châlons Camp) to Rheims, on October 30th, 1908, a cross-country trip of 16½ miles. The next day Blériot made his flight over La Beauce, from Toury to Arthenay and return, with one landing in between.

Czar Nicholas II of Russia had Sikorsky demonstrate the four-engined *Bolche*.

1913 (!): Nose of Prévost's Deperdussin racing monoplane. Note the propeller hub casing and the cowling round the 160 h. p. Gnôme engine. Vanes were fitted to the wheel discs to «pre-rotate» the wheels before landing.

This was the golden age of flying. Wilbur Wright had come to Le Mans to fulfil a contract with a French syndicate, and since August 9th had been demonstrating the undoubted superiority of his methods of flight. He flew with perfect ease at Les Hunaudières and then at the Auvours Camp, remaining in the air 1 hour 31 minutes, then 1 hour 9 minutes with Paul Painlevé as passenger. Finally he ended the year with a flight of 2 hours 18 minutes and a climb to 375 ft.

In September Orville Wright had been the first to remain in the air for more than an hour, at Fort Myers, near Washington, a feat which he repeated three times. As Louis Hirschauer wrote: "The year was a particularly rich one. It began with a flight of 80 seconds by Farman and ended with a flight by Wilbur Wright lasting a hundred times as long."

The structure of aircraft was also improved. Up to 1909 Blériot had flown only with paper wings. Special light-weight engines were occupying the attention of the manufacturers, and the Seguin Brothers built the *Gnôme* rotary engine, which was to revolutionize aviation.

During the years which followed, events crowded each other and only the basically important facts can be detailed.

The year 1909 saw the end of the experimental era and the beginning of the age of practical flying. On July 25th Blériot made the historic flight which separates these two periods. Leaving Calais in his Type XI monoplane with a 25 h. p. Anzani engine, he flew across the Straits of Dover to the cliffs of Kent, where he landed miraculously on the edge of a ravine; 23½ miles in 37 minutes, the first crossing of the sea and the first trip between one country and another in an aeroplane. No pilot of today, no matter how great, could repeat this exploit in such an aircraft and with such an engine. This is one of the features of the history of inventions, and particularly of aviation.

His success was so outstanding that within a few days Blériot had received orders for more than a hundred aircraft, which shows both the confidence inspired by his achievement and the great desire felt by people in all countries to take up flying.

The Flying Week at Rheims was the public expression of this attitude. Here records, races and new performances followed each other for eight days, before a crowd of sightseers from all over the world.

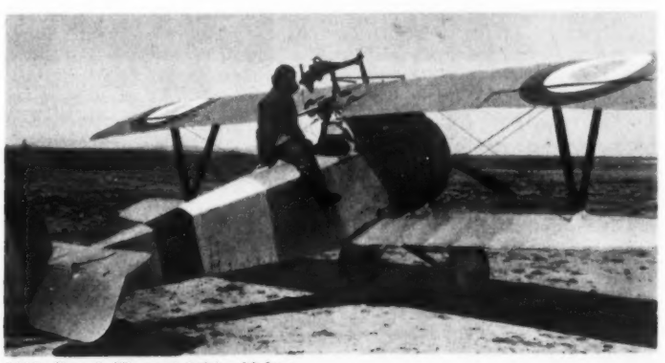
Finally, panting with emotion, Parisians saw a Wright biplane fly over the capital on October 18th, piloted by Count de Lambert, who flew well above the Eiffel Tower.

It was on March 28th, 1910, that a flying machine took off from the water for the first time. Piloted by its inventor, Henri Fabre, the "canard" type monoplane mounted on three floats took off from the Etang de Berre. On his third flight Fabre covered 4 miles, an outstanding feat since the pilot had never flown before. The seaplane's stability was doubtless due to the special design of the spars which, quite unintentionally, formed a slotted wing.

The first voyage in an aeroplane over a distance of more than 60 miles non-stop was made by Louis Paulhan during the London—Manchester race. Flying at night in a Henri Farman biplane he covered 110 miles.

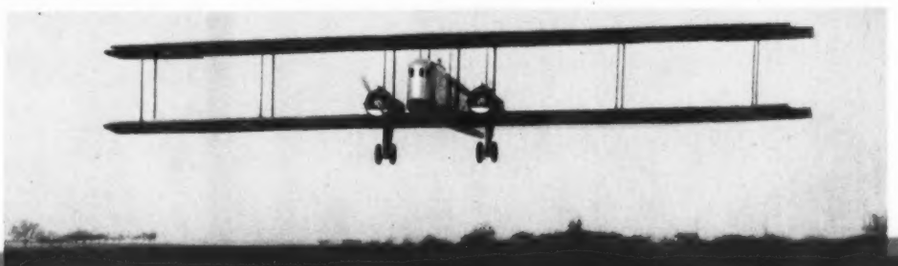
This was one of the first night flights, after those by Henri Farman and Sommer at the Châlons Camp. It was also Paulhan who had the

World War I: General John J. Pershing, Commander-in-Chief of the American forces on the Franco-German front in 1917 – 18, inspecting a squadron of Farman F. 20's at Le Bourget (rocket-firing tubes on the centre wing struts; swivel machine gun in fuselage nose).



1916: French Nieuport fighter biplane.

Civilian inheritance from World War I. After 1919 the converted Farman bomber became a passenger aircraft, under the name Farman 60 *Goliath*, on the infant European airlines (seats for twelve passengers).



idea of making and using a map roll. An amusing detail was that, since the course followed the railway line, a special train convoyed the aircraft at a suitable speed, and all other traffic was stopped on the line.

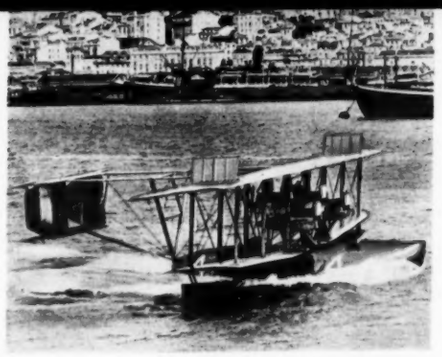
Latham, the great pilot of the *Antoinette* monoplanes, was the first to exceed an altitude of 1,000 metres (3,280 ft.).

New and far-reaching use of aviation was made in 1911 in San Diego by Ely, who landed his Curtiss aircraft on a cruiser and took off from it again. This was the origin of all aircraft carriers.

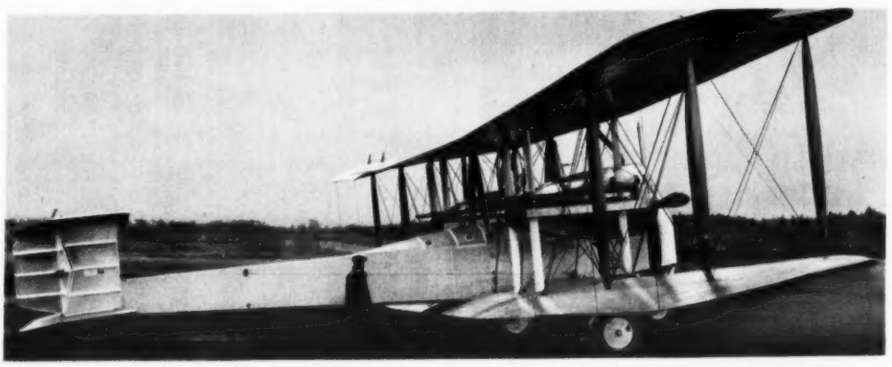
It is often thought that flying was dangerous at this period. Most of the early pilots affirm the contrary. Although accidents were fairly frequent, they were rarely serious. The amount of wood in front of and below the cockpit was sufficient to break the shock. Also, the speed of contact with the ground was low. Pilots who kept their wits about them had very few accidents, despite the low power of their engines. However, it is a remarkable fact that long trips, such as the circuit of Eastern France, Paris—Madrid, Paris—Rome, the round-England flight, were made in Blériot-Gnôme aircraft in which pilots would hesitate to leave the airfield today.

Aircraft construction was improved in 1912 by the introduction of the monococque structure, designed by Ruchonnet but put into practice by Bécherau. His machine, the Deperdussin, following the Nieuport monoplane of 1910, marks one of the principal stages in the history of human flight. It was a Deperdussin piloted by Prévost that was the first to cover a distance of 120 miles in less than an hour (September 1913).

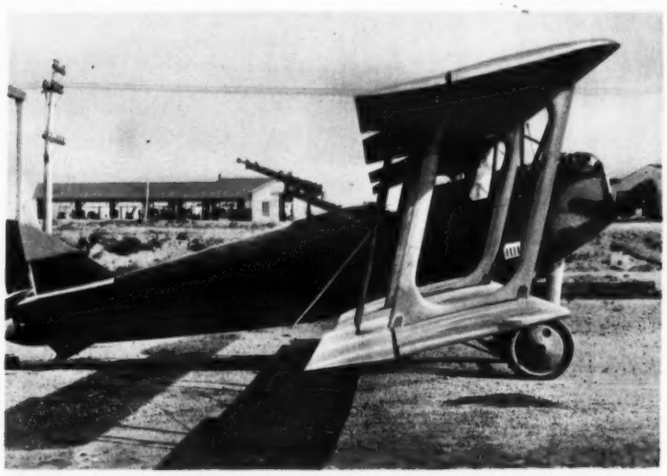
The year 1912 also saw the production of the first stepped-hull flying boat with wing-tip floats, high-set tail and raised engine, the Donnet-Levêque of Engineer Denhaut, which was the forerunner of most of the flying boats built during the next 20 years. Curtiss in the United States had built a flying boat in 1911, but without a step.



May 1919: First crossing of the Atlantic with intermediate landings. A four-engined Curtiss N. C. 4 seaplane of the U. S. Navy with a crew of six under the command of Lt. Col. Albert C. Read flew from Trepassey Bay, Newfoundland, via the Azores, Portugal and Spain to Plymouth, England. The Curtiss N. C. 4 after alighting at Lisbon.



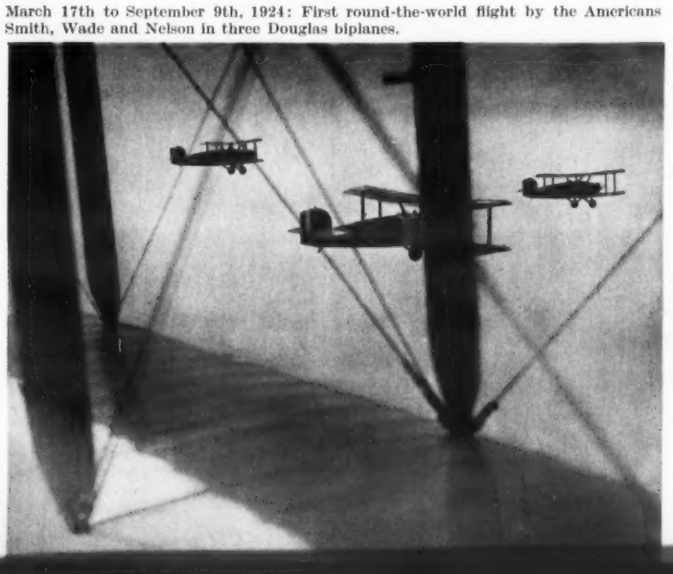
June 14th to 15th 1919: First non-stop flight across the Atlantic. Britons John Alcock and Arthur Whitten-Brown flew from St. John's, Newfoundland to Clifden, Ireland in 16 hours 12 minutes. Aircraft: Vickers *Vimy* biplane, two 365 h. p. Rolls-Royce *Eagle VIII* engines.



Aircraft reached the stratosphere back in 1920: The American Rudolph W. Schroeder was the first to climb to more than 10,000 metres (10,093 m. = 33,113 ft.), in a French Lepère biplane.

May 1923: First trans-continental flight from New York to San Diego. Pilots: Lt. John A. MacReady and Lt. Oakley Kelly. Aircraft: Fokker T-2 of the Army Air Service.

March 17th to September 9th, 1924: First round-the-world flight by the Americans Smith, Wade and Nelson in three Douglas biplanes.



1920: The Italian Arturo Ferrarin flew from Rome to Tokyo.

1924: Another Far East flight by an Italian: Francesco de Pinedo made a trip to the Pacific Islands and Asia in a Savoia S. 16 flying boat.

June to September 1926: French hearts went out to the Englishman Alan Cobham, who flew from England to Australia and back in a de Havilland seaplane. His welcome at Sartrouville on the way back.

May 9th, 1926: A blank spot disappears from the map. The Americans Rear-Admiral Richard E. Byrd and Floyd Bennet (pilot) were the first to fly over the North Pole during the Amundsen-Ellsworth Arctic expedition. Aircraft: three-engined Fokker VII.

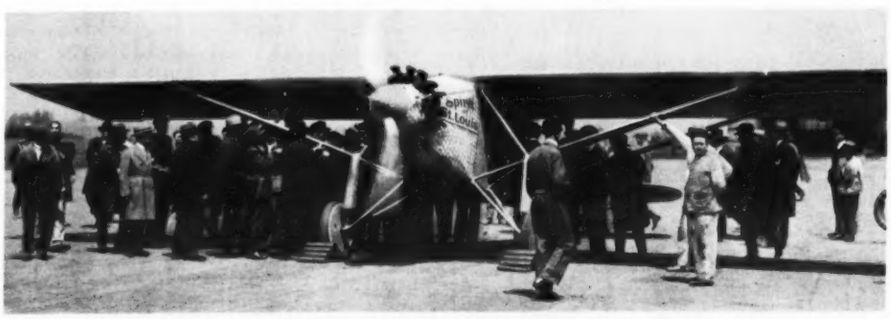
The next year, 1913, resembled 1903 for the progress made: Pégoud's first show flights in a Blériot, first flight over 120 miles by Prévost in a Deperdussin, first crossing of the Mediterranean by Roland Garros in a Morane-Saulnier, flights by the *Bolche*, the first multi-engined cabin aircraft built by Sikorsky, trips from Paris to Cairo by Bonnier in a Nieuport and by Jules Vedrines alone in a Blériot. These two astounding events were followed early in 1914 by Marc Pourpe, who flew from Cairo to Khartoum and back in a Morane-Saulnier. Up to this period France had unmistakably been the dominating country in flying, in machines, engines and pilots. Great Britain, Germany, the United States were all well behind and had not yet made up for their slow start; Italy, Holland and Austria were still further behind.

Germany woke up in 1914, with outstanding duration performances: 16 hours 20 minutes by Ingold: 21 hours 48 minutes by Landmann, and just before the war, 24 hours 12 minutes by Boehm in a Albatros, with a water-cooled Mercedes engine.

World War I introduced new techniques. Production in very large numbers, increases in speed, manœuvrability, range and load, altitude and rate of climb, tremendous growth in number of pilots, mechanics and specialists; very much improved power and endurance of engines.

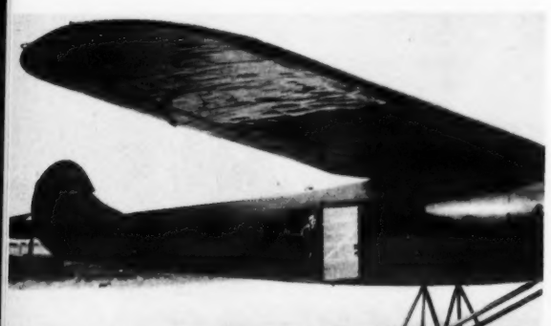
Modified military equipment was used as early as 1919 for civil air services, which were rapidly introduced in France, Great Britain and

The French "Air Union" opened the first service between Paris and London. The Schreck seaplane took off from the Seine and landed on the Thames. Pilot: Bajac.



May 1927: *The taming of the North Atlantic begins.* Lindbergh's Ryan monoplane "Spirit of St. Louis" (220 h. p. Wright engine) after landing at Le Bourget.

September 1st to 3rd, 1930: French non-stop flight across the Atlantic (east – west). Crew: Dieudonné Costes (left) and Maurice Bellonte. Aircraft: Bréguet biplane "Point d'Interrogation," before take-off from Le Bourget (flying time, 37 hours 18 minutes).



May 20th to 21st, 1932: First woman solo over the Atlantic. The American Amelia Earhart in her three-engined Fokker "Friendship" before starting out on the flight from Harbor Grace, Newfoundland, to Ireland.

1931: The German Dornier Do X twelve-engined flying boat in Rio de Janeiro bay. (Because of the restrictions imposed by the Versailles Treaty it was built in Switzerland.)

the United States. The basic model for the transport cabin was still that of the Farman *Goliath*, the great and glorious carrier of passengers in Europe.

The first long-range flights, in particular the crossing of the Sahara and the Atlantic, were also made in converted military aircraft.

The natural desire to use marine aircraft led the United States Navy to organize a crossing of the Atlantic by four Curtiss type N. C. flying-boats, three of them with three engines, the fourth with four. Only three took part in the expedition from New York to Newfoundland and the Azores. One was wrecked, the N. C. 3 had to alight on the sea and continue on the surface to the Azores.

The birth of mail flying in the United States: a Boeing mail plane over the Ruby Mountains, Nevada.

The N. C. 4, commanded by Read, completed the crossing, reached the Azores, Portugal and England. This was the first great flying exploit by the United States. A few days later Alcock and Brown flew a Vickers *Vimy* bomber landplane direct from Newfoundland to Ireland, the first outstanding feat in British aviation.

The two basic categories of aircraft, seaplane and landplane, had thus entered into competition. The latter was to emerge victorious, but not till much later.

1934: The Italian Francesco Agello set up a speed record of 709.209 km/h (440.7 m. p. h.) in a Macchi MC. 72 seaplane. This record has never been beaten for this class of aircraft.

Alighting on Lake Garda after the record flight.

A rousing welcome for the pilot, Francesco Agello.

Le Bourget Airport in 1938: A Potez 62 of Air France loading freight. The period of adventures is over: flying has become a normal form of transport . . .

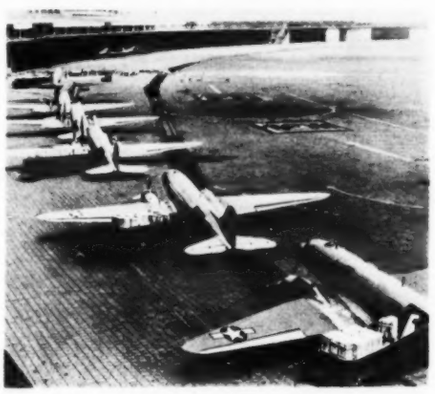
. . . Yet Milton Reynolds, the fountain pen manufacturer, still created a sensation in 1947 when he had himself flown round the world in four days in his "Bombshell," a converted Douglas A-26 *Invader* (pilot: William Odom).

The first non-stop crossing of the American continent by MacReady and Kelly (1924), the flight round the world by four Douglas aircraft, with floats for use when necessary (1924), must be entered to the credit of the United States, while Kingsford Smith was flying from London to Australia, Ferrarin from Rome to Tokyo in a landplane, de Pinedo was making a great trip in a Savoia flying-boat from Italy to the Pacific and Asia. Finally, the fast trip by Pelletier d'Oisy from Paris to Shanghai and Tokyo showed the rivalry between Britain, Italy and France.

The Polar expeditions by Amundsen and Ellsworth, the first flight over the North Pole by Byrd, the crossing of the Antarctic ice cap by Wilkins were new proofs of the variety of nations to which pilots and aircraft belonged.

The historic phase closed on May 21st, 1927, with the arrival of Charles Lindbergh at Le Bourget. He had left New York 33 hours 30 minutes earlier, alone in his small Ryan *Spirit of Saint Louis*. Like Blériot's, Lindbergh's exploit, carefully worked out and prepared, with equipment which was still modest though irreproachable, marked a definite stage in the progress of aviation.

So the first quarter of a century of flying came to an end. The second quarter has been marked by the practical development of the helicopter; by the introduction of jet propulsion, a capital advance which it is surprising to see appear so late, during World War II; by stratospheric flight, which dates from the most recent years; and above all by instrument flying, which is today taken for granted, since it is so well-known. It is to the anonymous airline pilots of the United States and particularly to Charles Lindbergh that we owe the introduction, in 1927, of this method of flight, which Rougerie brought to Europe with the co-operation of Etablissements Farman. Finally, an unexpected form of flying, namely gliding, became popular after 1922, much to the surprise of many observers.



1948/49: The aircraft keeps a city alive. Lining up for loading during the Berlin airlift.

Competition over the two Atlantics has been keen, between pilots and between nations.

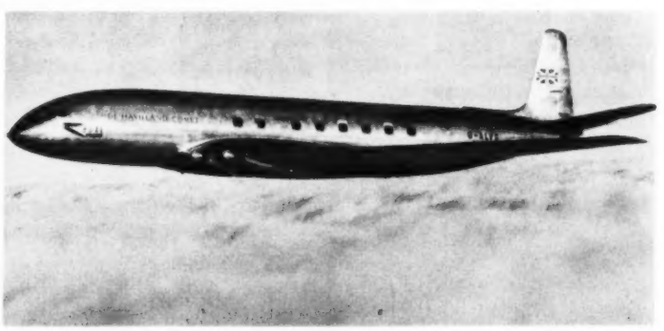
France holds an outstanding place here too, with the first non-stop crossings of the South Atlantic (Costes and Le Brix in a Bréguet 19, on October 14th and 15th, 1928 during their tour round the world), and of the North Atlantic from East to West (Costes and Bellonte in the Bréguet "?" on September 1st and 2nd, 1930.).

The distance record was beaten successively by Lemaitre and Arrachart (3 166 km in 1925), by the Arrachart Brothers (4,305 km), Girier and Dordilly (4,716 km), Challe and Weiser (5,174 km), Costes and Rignot (5,396 km) all in 1926 and all in the Bréguet 19, except the record by the Arrachart Brothers, who flew a Potez 28.

Since this period France has ceased to play a dominant role in aviation. In the years since World War II, trans-Atlantic services, previously operated for several years only by Zeppelin airships (the only aircraft ever to have operated non-stop services across the South Atlantic), have become the best and the most widely-used means of transport between the two Americas and Europe.

A brief halt in the restaurant at Gander, the point of call in Newfoundland, gives a vivid idea of the intensity and variety of trans-Atlantic flights. American, British, French, Dutch, Scandinavian, aircraft come in, carrying passengers from all over the world.

1953: One of French air transport's hopes, the Nord 2501.



1953: The de Havilland *Comet* jet airliner.

1953: Cabin of a modern American Atlantic aircraft, the Lockheed *Super Constellation*.

50 Years of Powered Flight

An American's Comments on the Wright Brothers Anniversary

BY WALTER H. WAGER, NEW YORK

On April 19th, 1709, King John V of Portugal granted a patent to Father Bartolomeo de Guzmao for an incredible iron airship to be filled with chopped straw and lifted by two large magnets attached to the deck. An overhead canopy serving as a horizontal sail would catch rising air currents generated by a huge bellows in the hold, and heated pieces of amber were to produce static electricity to draw the straw upward. Armed with this exclusive franchise, but no mail contract, the imaginative cleric designed a somewhat different machine based on the physical fact that hot air rises and flew [1] in it before the assembled nobles of the court. He didn't get very far, for in 1717 the Holy Tribunal ignored his royal patent and tried the earnest inventor for witchcraft. All public documents on the device were burned by the solemn Tribunal, and Father Guzmao tossed into a dungeon. He later escapted to Spain, where he perished shortly afterwards.

This historic ascent accurately presaged the development of U.S. air transportation, for while modern Lockheed *Super Constellations* and Douglas DC-7's can skip along a lot higher, further and faster without any serious fear of ecclesiastical interference, flying is still closely regulated by government controls, and commercial sky services are wholly dependent on federal franchise. Any impartial observer of the airlines' behavior and testimony at Civil Aeronautics Board route proceedings and mail pay hearings can attest as to the continuing importance of "hot air." While it is admitted that most of the scheduled carriers no longer treat their passengers as sheep, like the quadrupeds and ducks of the brothers Montgolfier, an honest airline executive will confirm that there are still some mighty queer ducks in the industry. Finally, the bright boys are still on the ground "flying" pickled pine desks in New York, Chicago and Washington, and both the Department of State and its overseas missions are vitally interested in this rapidly shrinking, unpleasantly strategic air world.

First Americans to fly were probably the courageous Peter Carnes and thirteen year old Edward Warren who went up over Baltimore in a Montgolfier-type balloon in 1784, but the fabulous saga of U.S. air transport really began with Orville Wright's initial twelve-second ascent nine feet over the sandy dunes of Kitty Hawk, North Carolina, on the chill grey morning of December 17th, 1903.

[1] As reported in Wilson and Bryan's "Air Transportation," published by Prentice-Hall, 1949.

The United States Post Office began airmail experiments as early as 1911. The first mailpouch being handed over to the pilot.

Today? There are eighty big, safe, comfortable airlines in the sky over the United States right now; they're part of the scheduled carriers' fleet of over 1,500 speedy multi-engine transports. Equipped with the latest devices for all-weather flying, operating between good airports over routes abundantly supplied with excellent electronic navigational aids, they hauled 30,000,000 passengers last year. Year in and year out, international surveys note that the five biggest airlines in terms of passengers, freight, flights and fleet are U.S. operators.

A lot of money was spent on flying machines during World War I, but Uncle Sam got precious little for it in terms of American combat aircraft delivered to the fighting front. European States began subsidizing their carriers in 1919 and 1920, but the U.S. had only a Tampa-St. Petersburg service, and no proper transport planes were available. In those first post-war years, American aviation consisted largely of barnstorming stunt pilots flying obsolete surplus aircraft. The Post Office, which had been experimenting with air mail flights since 1911 and pounding away at skeptical Congressional committees for funds to finance regular flying deliveries, finally jarred loose $ 100,000 and started the New York—Washington air mail route with Army planes on May 15th, 1918. The commercial airlines grew slowly until the Kelly Air Mail Act of 1925 authorized transfer of air mail service to private operators who could enter competitive bids for four-year contracts. By September, 1927, all air mail was moving on commercial carriers.

The Kelly Act of 1925 set the policy which provided the funds for development of scheduled U.S. airlines. Passenger traffic grew slowly in the twenties and thirties, for inadequate aircraft resulted in high operating costs, poor safety records, and limited loads. It was the air mail payments that enabled the carriers to hang on by their teeth until better transports, simple, reliable, economic types like Donald Douglas' pace-making DC-3, came into service in 1937 and brought the possibility of independence from federal aid into sight.

Airline executives as different as hard-boiled, self-made, correspondence school educated Eddie Rickenbacker, the shrewd, union-cussing, paternalistic "Captain" of Eastern Air Lines, and suave, soft-spoken, tough Yaleman Juan Terry Trippe of Pan American World Airways have a common tendency to grit their teeth at the dirty word "subsidy."

Although Eastern is now one of the "Big Five" domestic trunk operators (American United, Trans-World, Eastern and Northwest) and one of the fourteen U.S. internal airlines carrying mail at "service" rates which the overworked economic experts of the C. A. B. have officially pronounced free of subsidy, it was not so long ago that the independent, anti-socialist Mr. Rickenbacker was living on New Deal dollars. This is no reflection on the top U.S. fighter ace of World War I, for the other carriers also survived on federal cash in the romantic but lean years before modern economic planes and the great public acceptance of air travel which came with World War II. The scheduled operators' Air Transport Association, a powerful body whose mild general counsel wrote a good chunk of the 1938 law and stayed on to become one of the most effective lobbyists in Washington, reports that 98 % of domestic air mail last year was carried at "service" rates.

*

U.S. international airlines are proceeding slowly down the same road to financial independence, but they have a longer, tougher row to hoe. Overseas traffic is lighter, operating costs are higher, and competition is more intense. As air historian Henry Ladd Smith pointed out a few years ago, "the myth has been fostered that Trippe was something of a wizard in the way he swallowed up competitors, expanded his routes and negotiated for mail contracts. Admittedly, no one ever got back too much change from Mr. Trippe. Those who underestimated his shrewdness usually were singed. But the truth is, legerdemain had less to do with his success than his help from the U.S. Government." Scion of an old Eastern banking clan, Juan Trippe has always had a keen eye for the financial and political aspects of air transport, and he has used these real talents in the patient construction of the greatest international sky carrier in the world. Even his competitors admit that he has done a good job.

He's not too likely to return the compliment, for Pan American has never been enthusiastic about the idea of competition.

Well known are the stages of Jean Trippe's unrelenting campaign since P. A. A.'s formation in 1927 for the creation of a U. S. international airline monopoly. From 1927 to 1935 he swept through the Caribbean and Latin America; in 1935 he launched his big *China Clipper* flying boat to the fabled Orient; he began trans-Atlantic flights in 1939 after securing landing through the State Department in a fantastic dual with the British competing carrier; he fought the Atlantic competition of American Overseas Airlines and Trans-World Airlines which had emerged from the war. He propagated a "single chosen instrument" for U. S. overseas airline operations, in which Pan American would have played the leading part. He attempted to merge with T. W. A. (1945—1947) and finally absorbed American Overseas in 1950.

The dog-eat-dog struggle continues. There's a tough old Dutchman named Albert Plesman, veteran head of Holland's global K. L. M. sky network, who operates on the principle that "If you know what you want, you're ahead of eighty per cent of the world right there." Mr. Trippe knows what he wants. Warren Lee Pierson, T. W. A. Board Chairman, Harold Harris, President of Northwest, and Charles Beard, Executive Vice-President of Braniff Airways know it too.

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Their companies and the other U. S. overseas operators have come a long way since fiscal year 1938 when America's international airlines derived 55.8 % of their revenues from mail pay, most of it subsidy. Autoritative estimates for fiscal 1953 indicate that only 18.8 % of their income will be postal payments, with a smaller proportion subsidy than in the past. Total mail revenues of U.S. international sky carriers for fiscal 1938—53 were $458,200,000, which averages out to $12.88 for each of 35,600,000 taxpayers and $2.86 for each of our 160,000,000 citizens.

That's small potatoes in the federal aid program, and only 40—65 % of airmail payments since the Act of 1938 can be accurately classified as subsidy. Indeed, the government's cash loss on flying the mails is peanuts compared to the half billion dropped in supporting potato prices in 1947—51 alone. As for peanuts themselves, Uncle Sam shelled out $117,100,000 to hold up their price levels between June 30th, 1947 and November 30th, 1952. The combined loss of peanuts and cheddar cheese adds up to $209,800,000, which is a lot of money for hors d'œuvres. For considerably less cash, we've bought the best airline system in the world—useful in peace and essential in war.

According to data which Oliver Lissitzyn, Columbia professor and international aviation expert, gathered for the Senate Commerce Commitee, just about every foreign government is subsidizing its national carrier in a variety of ways. Despite this competition, U.S. services are moving 35 % of the air passengers on the North Atlantic while the airlines of eleven other countries split the rest.

The Republican-dominated economy-minded Board recently announced that next year scheduled U.S. airlines will get $56,000,000 for transporting mail and some $80,655,000 in subsidies. Our international operators will receive 63 % of the subsidy, $50,854,000. Domestic carriers will get $29,801,000 in subsidy, with $23,900,000 going to "local service" operators who fly regional feeder routes linking smaller communities to the big unsubsidized trunk lines. There is considerable doubt whether these feeder services are remotely economical with present planes, but political pressure has helped to prevent the C.A.B. from terminating their costly "experimental" franchises. The eventual answer to the demand for short-haul air services may lie with the big helicopters going into production at the Sikorsky and Piasecki companies, but they're not cheap to buy or operate either.

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Fifty years after the Wright Brothers and fifteen years after the Civil Aeronautics Act, the United States has a big strong air transport industry with scheduled carriers whose assets top one billion dollars and whose skilled personnel number over 100,000.

Today: A P. A. A. Atlantic Clipper taking on mail and freight.

In the twenty-eight years since the Kelly Act of 1925 put the airlines on a paying basis, the history of this young industry has been stormy. Scandals and frauds caused the Post Office to cancel all domestic air mail contracts in 1934, to bar arbitrarily from any company flying U.S. mail many high executives of the carriers involved in the mess. In 1935 F.D.R. named the Morrow Board to resurvey American aviation. Then there were congressional hearings in 1937—8, and special research studies by federal teams in 1939 and 1940. When zooming operating costs stunned the post-war airline boom in 1947 and aircraft factories slowed down with declining defense orders, the whole aviation industry was dramatically reexamined by both the President's Air Policy Commission and an eagerly competitive Congressional Aviation Policy Board. In 1948, the inter-departmental Air Co-ordinating Commitee ground out its own broad survey. Meanwhile, however, the economic picture had changed and most of the carriers weren't interested any more, as they were making good money.

•

They still are. Despite a steady increase in operating costs, they were doing so well that the C.A.B. was going to look into a fare cut—but all that went with Harry Truman. The new Administration found the non-scheduled operators battling the scheduled carriers, and the latter wrestling among themselves in uninhibited competition for traffic on existing routes and for certificates for new franchises, found a reasonably healthy industry that was finally making money after years of dependence on federal assistance and that was loudly complaining about too much government interference. After twenty-eight years at the public teat, the lusty brat was practically weaned but still noisy.

The subsidy picture has now been clarified as a result of Senator Ed Johnson's, of the Senate Commerce Committee, patient pressure on the C. A. B. There may be even better years ahead, for the Post Office is running a one year test on the possibilities of sending all first class mail by air. American, T. W. A., United and Capitol are expected to tote some 2,000,000 pieces of additional mail each day between Chicago and New York—Washington at roughly half of present "service" rates. President Eisenhower has instructed the Air Co-ordinating Committee to initiate a complete reevaluation of U.S. aviation policy, and the Senate Commerce Committee has scheduled a sweeping new investigation of the 1938 statute and its efficacy. No one can say just what the results, if any, will be, but Old Mayflower Hands will probably find some consolation in the thought that jets are on the way, so all the hot air may come in handy. After all, Father Guzmao found it useful and so did the Montgolfiers. That's how flying began.

Faster and higher

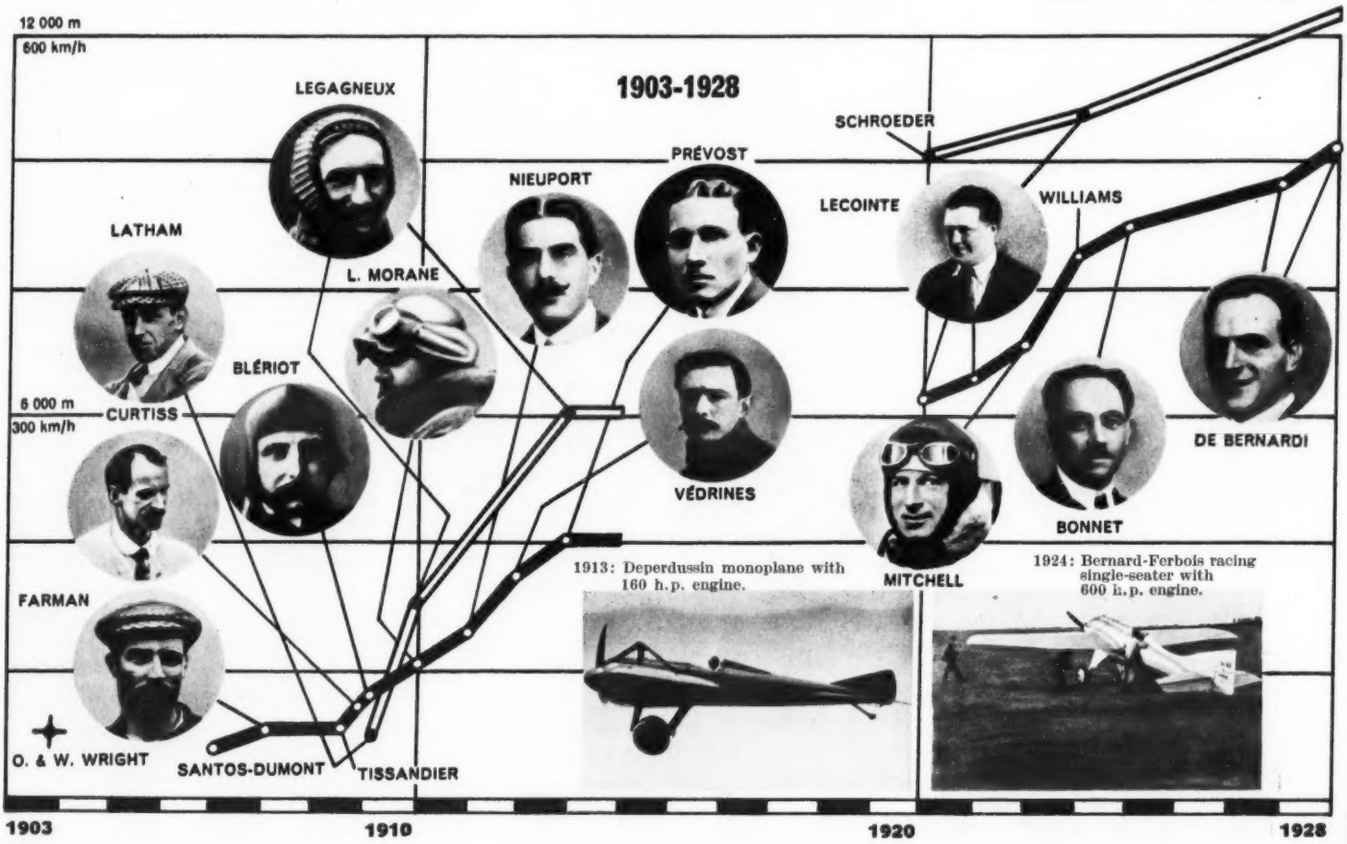
SPEED AND ALTITUDE RECORDS

I: World speed records

Year	Pilot (Country)	Aircraft	km/h	m.p.h.
1903	Orville & Wilbur Wright (USA)	Wright	50	31
1906	Alberto Santos-Dumont (FRN)	Santos-Dumont	41.3	25.7
1907	Henri Farman (FRN)	Voisin	52.5	32.7
1909	Tissandier (FRN)	Wright	54.8	34.1
1909	Glenn Curtiss (USA)	Curtiss	69.8	43.3
1909	Louis Blériot (FRN)	Blériot	76.0	47.0
1910	Leon Morane (FRN)	Blériot	106.5	66.2
1911	Edouard Nieuport (FRN)	Nieuport	133.1	82.9
1912	Jules Védrines (FRN)	Deperdussin	174.1	108.2
1913	Maurice Prévost (FRN)	Deperdussin	203.9	126.7
1920	Sadi Lecointe (FRN)	Nieuport-Hispano	313.0	194.5
1921	Sadi Lecointe (FRN)	Nieuport-Hispano	330.3	205.2
1922	William E. Mitchell (USA)	Curtiss R-6	358.8	223.0
1923	Alford J. Williams (USA)	Curtiss R2C-1	429.0	266.6
1924	Bonnet (FRN)	Bernard-Ferbois	448.2	278.5
1927	Mario De Bernardi (ITL)	Macchi MC. 52	479.3	297.8
1928	Mario De Bernardi (ITL)	Macchi MC. 52	512.8	318.6
1929	A. Orlebar (GBR)	Supermarine S. 6	575.7	357.7
1931	G. H. Stainforth (GBR)	Supermarine S. 6B	655.0	407.0
1933	Francesco Agello (ITL)	Macchi MC. 72	682.1	423.8
1934	Francesco Agello (ITL)	Macchi MC. 72	709.2	440.7
1939	H. Dieterle (DEU)	Heinkel He 112 U	746.7	463.9
1939	Fritz Wendel (DEU)	Messerschmitt Me 109 R	755.1	469.2
1945	H. G. Wilson (GBR)	Gloster «Meteor Mk. 4»	976.0	606.5
1946	Edward M. Donaldson (GBR)	Gloster «Meteor Mk. 4»	991.1	616.0
1947	Albert Boyd (USA)	Lockheed P-80 R	1003.7	623.8
1947	T. F. Caldwell (USA)	Douglas D-558-1	1031.2	640.7
1947	Marion E. Carl (USA)	Douglas D-558-1	1047.4	650.8
1948	Richard L. Johnson (USA)	North American F-86 A	1079.8	671.0
1952	J. Slade Nash (USA)	North American F-86 D	1124.1	698.5
1953	William F. Barns (USA)	North American F-86 D	1134.4	715.7
1953	Neville Duke (GBR)	Hawker «Hunter Mk. 1»	1171.0	727.6
1953	Michael J. Lithgow, (GBR)	Supermarine «Swift 4»	1186.5	737.3
1953	James B. Verdin (USA)	Douglas XF4D-1	1212.5	753.4

II: Some outstanding altitude records

Year	Pilot (Country)	Aircraft	m	feet
1910	Hubert Latham (FRN)	«Antoinette»	1 000	3 300
1910	Georges Legagneux (FRN)	—	3 100	10 200
1913	Georges Legagneux (FRN)	—	6 100	20 000
1920	Schroeder (USA)	Lepère	10 100	33 100
1923	Sadi Lecointe (FRN)	—	10 750	35 200
1929	Willy Neuenhofer (DEU)	Junkers W. 34	12 739	41 700
1930	Apollo Soucek (USA)	Wright «Apache»	13 157	43 170
1934	Renato Donati (ITL)	Caproni Ca. 113	14 433	47 350
1937	M. J. Adam (GBR)	Bristol 138	16 440	53 940
1938	Mario Pezzi (ITL)	Caproni Ca. 161 bis	17 083	56 050
1948	John Cunningham (GBR)	«Ghost-Vampire»	18 119	59 450
1953	W. F. Gibb (GBR)	Bristol «Olympus-Canberra»	19 404	63 670



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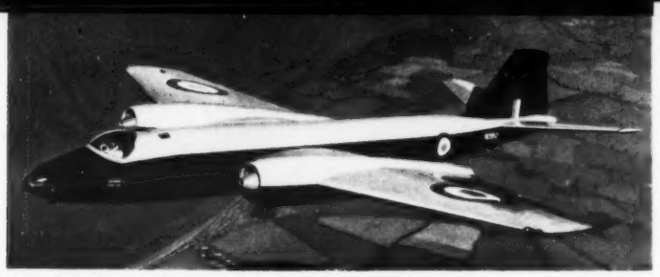
Uruguay	Pesos 28	R. F. Besnard, Edificio Artigas, Rincon 487, Montevideo.
U.S.A.	$7	Interavia, 155, Madison Avenue, New York 16, N.Y.

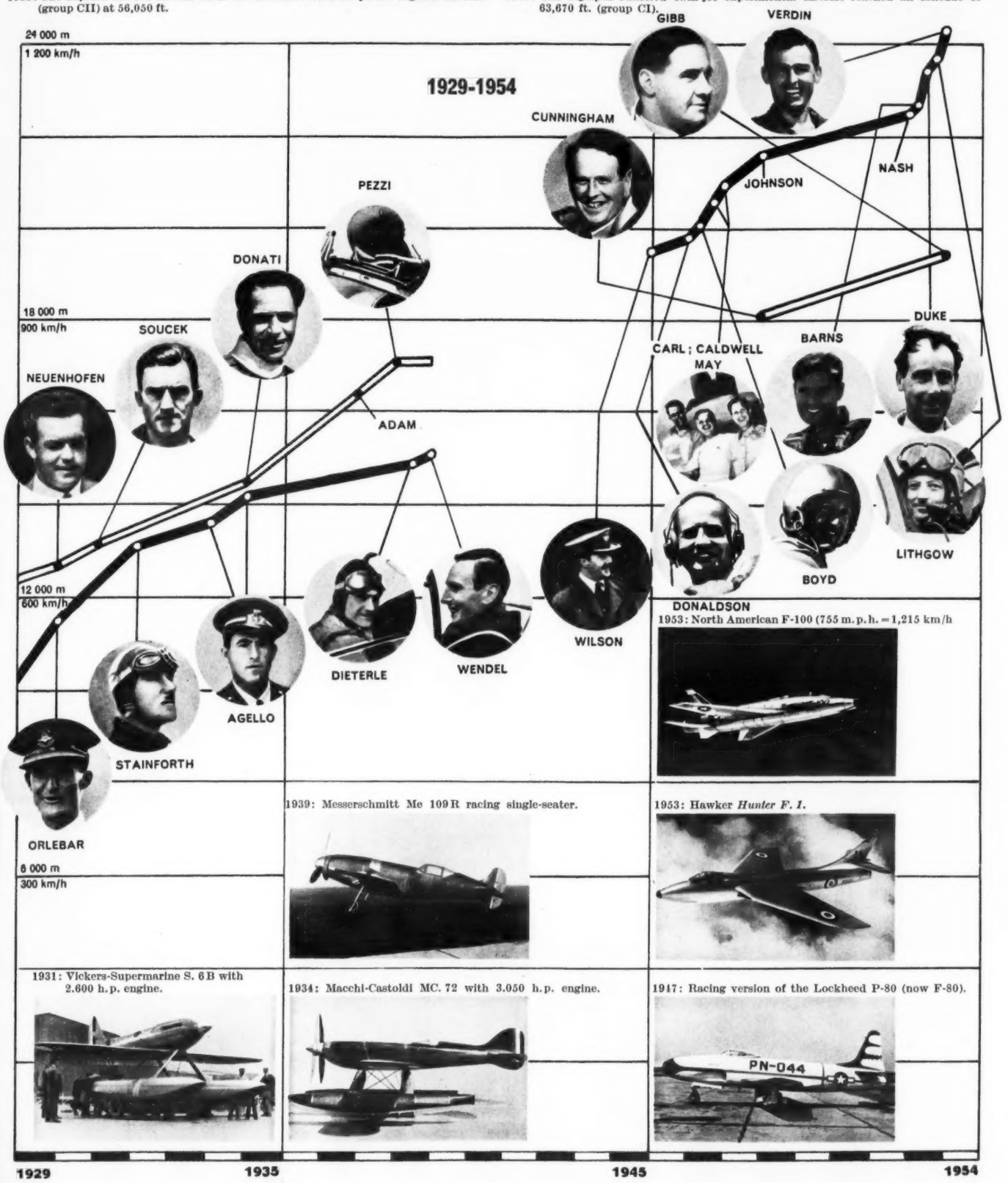
1929

VOLUME

1938: The Caproni Ca. 161 bis still holds the altitude record for piston-engined aircraft (group CII) at 56,050 ft.



1953: The *Olympus-Canberra* twin-jet experimental aircraft reached an altitude of 63,670 ft. (group CI).



50 Years of Powered Flight

1920: The Douglas Aircraft shop was in the back of a barber shop near Los Angeles. The production area above was the corner of an old lumber planing mill. Under construction is Douglas first aircraft, the *Cloudster*. Donald W. Douglas is the young man in the cockpit at right, with a small moustache and wearing a dark coat.

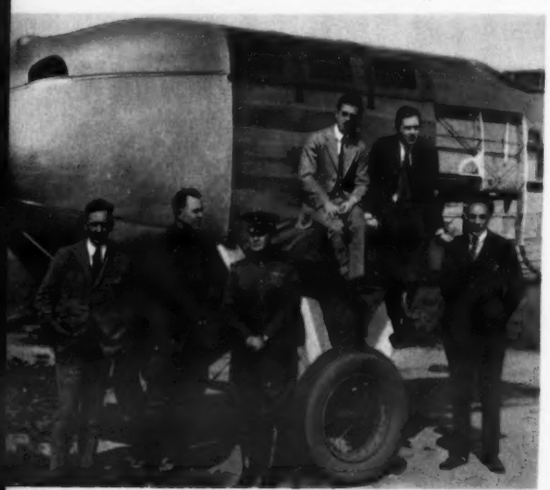
F. W. Conant

Thirty-three Years of Aircraft Manufacture

BY FREDERIC W. CONANT VICE-PRESIDENT-MANUFACTURING, DOUGLAS AIRCRAFT COMPANY, SANTA MONICA, CALIFORNIA

Any attempt to describe in detail today's manufacturing processes would require more pages than a many-volumed encyclopedia. But progress in the field can be glimpsed graphically by comparing pioneering methods with present-day practices.

It is a far cry from the early days, when a half-dozen employees literally wired and glued an airplane together under the direction of the lone engineer who had designed it. Only the most ordinary tools were available. Today a number of engineering departments design, plan and supervise the building of aircraft. Thousands of people work in an aircraft plant, and they use specially-designed tools and machines which can cost up to $500,000 apiece.



The Douglas *Cloudster* is nearly complete. Sitting on the wing stub are, left to right, designers David Davis and Donald W. Douglas.

For example, Douglas Aircraft Company began 33 years ago in the back of a barber shop, with a corner of an old lumber planing mill as the production area. Now there are four Douglas plants—at Santa Monica, El Segundo and Long Beach in California and at Tulsa, Oklahoma—with the California plants alone occupying just under 1,110,000 square yards (928,071 square meters). The approximately 65,000 Douglas employees are classified in 612 different factory, technical and administrative jobs.

Growth is not the only change, of course. Methods have been revolutionized completely since the early days of powered flight—particularly since 1920. The most striking changes can be seen in the fabrication and assembly of airplanes, but the most significant changes have come about in design and engineering technique.

In the old days there was only one performance requirement: the ship had to fly. (No one could be sure a plane would do even that until the post-completion tests). Any other advantage in a particular airplane's performance was the result of haphazard inspiration or just plain luck.

Today performance requirements are established first. When the Preliminary Design Group set to work they already know what speeds the aircraft must achieve, the payload, take-off length, and even operational costs. This Group suggests the kind of airplane that will meet the requirements, and a series of variant models are made and tested in wind tunnels. After the aerodynamic superiority of a particular model has been established, design engineers take over the project.

The problem at this point is to design an interior which will accommodate load specifications, passenger comfort, etc. More important, the flexural characteristics of the structure are predicted and tested. Electronic calculators are used in establishing their prediction. A giant "brain" solves mathematical problems in eight hours that would otherwise take six months of tedious figuring by a hundred scientists.

The Tooling and Planning Division plans the method of manufacture and the necessary tools. Today aircraft manufacturing tools have to be created specially and timed to move into the

Today's modern production lines at the Douglas plants: Left: Douglas AD *Skyraider* naval attack aircraft at the El Segundo factory; right: Douglas DC-6B commercial transports at the Santa Monica plant.

Douglas C-124A *Globemaster II* giant military transports at the Long Beach plant.

shop with the thousands of blueprints needed for actual construction.

Uncertainties in the use of materials are removed by advanced methods of non-destructive testing—both sonic and X-ray—to assure maximum usefulness. New materials which contribute significantly to aircraft progress have come into existence. Others are constantly being developed. Titanium is a recent conspicuous example.

At last the fabrication of the airplane can begin. In the wire and cloth era there was hardly any tooling, and modern power machines were not in existence. Later, fabrication was mostly hand-formed, the job of sheet metal craftsmen. In large factories like those of Douglas, Class A dies, with tolerances of a few thousandths of an inch, heavy presses and enormous drop hammers make the parts uniformly and economically.

After fabrication, the parts are assembled on an adaptable assembly line. In the Douglas Santa Monica plant, for example, the DC-6A, DC-6B, U.S. military versions of these models, and the new DC-7 are assembled on the same line. This is not the kind of mass-production typical of the automobile industry, but a satisfactory system of using advanced techniques to assemble custom-built airplanes.

During installation, the tubing, wiring and controls are functionally tested. Inspection and testing are continuous, in fact, in every operation of the fabrication and assembling processes. At the end of the line the engines and propellers (if the aircraft is piston-powered) are installed and the airplane is ready for a series of final inspections.

Upon completion, the airplane is thoroughly flight-tested in accordance with predetermined schedules and procedures. The performance tests coincide remarkably with the performance requirements specified before the Preliminary Design Group ever started its work.

In the old days aircraft production was mostly guesswork, improvisation, adventure and romance—today research, design and technically-advanced construction. There is romance too, but the romance is in the skies, and the adventure in the achievements of the men who fly.

Hall L. Hibbard

From Glue-pot to Hall of Giants

BY HALL L. HIBBARD, VICE-PRESIDENT-ENGINEERING
LOCKHEED AIRCRAFT CORPORATION, BURBANK, CALIF.

Yesterday's airplanes were built to satisfy a simple need—the urge to fly. Today's airplanes are built to satisfy enormously complicated needs: varied air defense missions of governments, plus extremely precise performance and economic requirements of airlines.

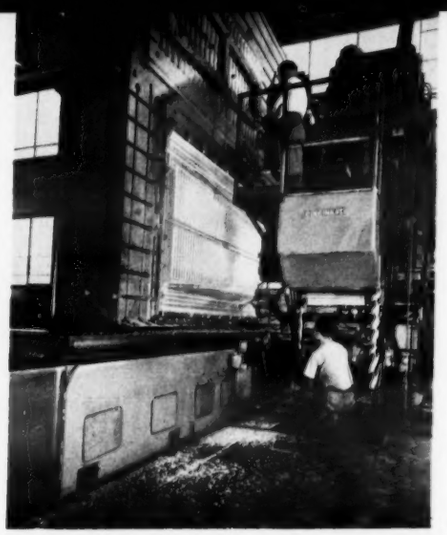
More than any other major industry, aviation in only a few years has revolutionized its design and manufacturing methods. Airplanes no longer are hand-fashioned with components picked off a shelf. Today they are built under a complex system co-ordinating aerodynamic requirements with practicable manufacture, simplified maintenance and assured economy of operation.

This precise planning is a requisite of each of the six basic phases of modern manufacture: (1) design, (2) mockup and systems testing, (3) tooling, (4) building up and filling a supply pipeline, (5) actual production, and (6) continuing design improvement. Each step requires new concepts, and each concept demands continuing research.

Since Lockheed began production on its *Constellation* series, for example, an average of 40 design changes have been in work at all time to meet and anticipate customer demand. Lockheed

The aircraft industry has come a long way from the Wright Brothers' wooden shed to its vast, modern factories of today. This is one of the Lockheed factories at Burbank, Calif.

The 20-ton Ceco stamping machine in Lockheed's "Hall of Giants". It can stamp sheets up to 10 feet long by 8 feet wide. It is mounted on a 16-foot-high solid concrete inertia block which floats on springs to damp vibration.



Modern production techniques: Lockheed's Cincinnati Hydrotel milling machine is here cutting a self-strengthened wing panel for an F-94C *Starfire* interceptor.

jets also show how a good design can be kept modern to do new jobs. The original F-80 *Shooting Star* jet fighter grew into the two-place T-33 trainer, standard jet trainer for the free world's pilots; and the T-33, with electronics, afterburner and armament, grew into an interceptor—the F-94C *Starfire* which was ready for duty years ahead of any other all-weather fighter.

Today, Lockheed employs 4,000 engineers. Their work in the fields of metallurgy, electronics, hydraulics, aerodynamics, astrophysics, chemistry and a host of other specialized sciences, is a vital ingredient of modern aircraft building.

Keen competition in world aviation demands aircraft which not only must fly high, fast and far, but they must do so at lowest possible cost. Designers therefore must keep in constant touch with air line operators, back up their own common sense with scientific market research and fit the needs of years ahead into a design that becomes fixed today.

Following design conception, mockup and systems testing begins. Sample parts are subjected to stress, strain, chemical analysis, X-ray tests, wind tunnel experimentation and many other checks. Engineers set up whole systems, such as the hydraulics and control mechanisms of *Super Constellations*, and give them a "lifetime" of laboratory operations—all before actual production starts.

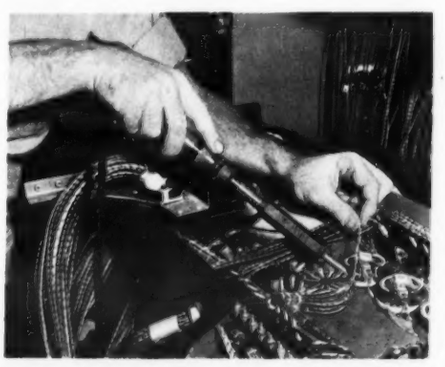
Continuous research: landing gear is being subjected to test in the research drop tower at Lockheed's Burbank plant.

During the last 20 years, research at Lockheed has changed from a part-time job for less than a dozen people to a full-time operation involving more than 1,000 specialists.

Tooling for production is a monumental job in itself, utilizing the skills of jig and fixture builders, tool and die makers and machinists—a total of 2,350 tooling employees.

Maintaining the logistics pipeline is another big task. Besides its own output, the manufacturers must create a network of thousands of companies to supply power plants and screws, landing gear and rivets. On one airplane, the P2V *Neptune* anti-submarine defender, 51 per cent of the structure is sub-contracted. Huge machines, such as those in Lockheeds "Hall of Giants", illustrate the aircraft manufacturing revolution. Some hand work continues, but the trend is to larger individual pieces, self-strengthened by special shapes that are milled, extruded or forged. One-piece skin panels for the wings of the Lockheed F-94C *Starfires* are formed and cut by one of these huge machines.

Million-dollar machinery is replacing the hand tool. One Lockheed triple-action hydraulic draw press has an 8,000-ton capacity and exemplifies the tools being developed for lighter, stronger structures. New machines contribute much to modern manufacturing methods. But the emphasis still should be placed on men and their ideas rather than their tools. Aircraft men now employ such once unheard-of techniques as heat treating; large lightweight plastic dies; tougher steels and alloys of aluminium and titanium; optical tooling and impact extrusions. Modern manufacturing also requires new ideas in plant layout, sub-contracting and other "intangible" production aids—all meshed into a smooth production flow.



Some hand work continues, such as in the assembly of radio equipment.

The product takes shape: Lockheed *Super Constellations* on the final assembly line.

One certainty exists in any appraisal of today's methods: unquestionably the method and the product will change for the better tomorrow.

Far from staying static, the science and art of aircraft design and construction will expand and branch out. Airplanes will have increasingly greater impact on people everywhere. The road ahead is an aerial road and we have just begun to climb up to it.

Grandfather Taught us How

BY GABRIEL VOISIN, PARIS

The name of Gabriel Voisin is so closely linked with the history of flying that there is no need to introduce the oldest living aircraft builder and flyer in the world.

At 74, Gabriel Voisin still has not only a youthful figure but all the verve and uncompromising energy that have always been his. -Ed.-

> Designing an aircraft is nothing.
> Building it is but little.
> Testing it is everything. FERBER

Conditions have changed since Ferber honoured me with his friendship—if designing an aircraft is still nothing, as in historic times, building it has become difficult. As for testing it, a series of fearsome official barriers has been set up against even the most elementary tests under acceptable economic conditions, and in France this situation has had the inevitable consequences.

The last French speed record (a world record, not one dolled up with a fancy name) dates from 1924; it was 448 km/h (278.5 m p.h.). There were no French participants in the recent London—New Zealand "race of the Century," which is surprising and disappointing, for France was indisputably the birthplace successively of the free balloon, the dirigible and the aeroplane, whose creators were Frenchmen—Montgolfier, Colonel Renard and Clément Ader.

I belong to the army of elderly men who, as everybody knows, grumble the whole day long. But say what you like, the men of my generation received an education based on "foresight."

In the year of grace, 1890, when I was about ten, my maternal grandfather Charles Forestier directed our childhood, and my brother and I were subjected to the strictest discipline. "The Old Man," as we called him in secret, was by no means an ogre. He was a man of culture, and his best friend had been the poet Lamartine. We were not child martyrs but we were brought up on the principle of "spare the rod and spoil the child."

Neuville sur Saône, near Lyons, where our schooldays were spent, is one of the pleasantest regions imaginable. The south wind which blows there, funnelled by the surrounding hills, has exceptional force and regularity on the plain to the north of the village, which was a favourite spot for all the boys of the neighbourhood to launch the kites of those days with their fluttering paper tails.

Grandfather did not come with us to the kite field, but he kept a strict eye on our models and on the smallest details of our ventures.

Our kite projects naturally grew each year under Grandfather's supervision. They were, of course, the best in the neighbourhood and we came back to the fold bursting with pride at our successes.

In 1894 Grandfather left us, and I really grieved for him. This stern old man, always quick to chastise, loved us in his fashion. Two years earlier he had "given" us a small shed, with a bench, two vices, a boring machine and a portable forge.

*

From 1895 to 1897 we abandoned kites for sailing. Such boats as we could get hold of were furnished with more or less successful sails, the materials for which we found in our mother's cupboards, where a pile of worn sheets awaited our exploration.

It was not until 1898 that we first learned about the Hargrave kite from a magazine. Our first Hargrave, made of two equal-sized cubes one behind the other, astounded us. Up till then we had seen nothing but Grandfather's type of kite, which despite all our care could barely carry its cord. Our Hargrave, on the contrary, which flew without long tail of fluttering papers, conquered the skies of Neuville at an impressive angle.

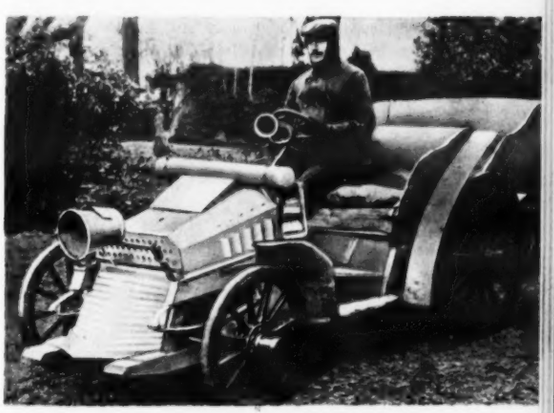
Two days after our first experiment we started building a Hargrave whose cubes measured two metres in each direction, made, of course, from sticks and sheets from mother's cupboard.

The first time we tried it out our machine was crushed by the wind, and we had to look around for the proper way of building it.

We were living at that time in a charming house by the Saône, at Villenert-Neuville. In the garden there was a magnificent clump of bamboo. Having carefully chosen what we needed and cut it out in secret, we easily made a solid framework, but found it had no rigidity. One of our neighbours revealed to us the mysteries of articulated structures, and our new Hargrave of cloth and bamboo put up an impressive resistance to the strongest southerly winds.

It was during a particularly successful launching in gusty weather, while I was holding the cord on a picket and my brother lifted the kite

Gabriel Voisin in 1953, a young man of 74.



Brother Charles at the wheel of one of the first Voisin automobiles.

April 3rd, 1904: Author's first glider flight over the sand dunes of Berck-sur-Mer.

Towed flight experiments in an engineless seaplane on the Seine.

January 13th, 1908: Henri Farman taking off in a Voisin biplane on his historic flight over a one-kilometre closed circuit.

into the air, that he told me with astonishment, "I thought for a moment that I would be carried up too, if I hadn't let go." I then changed places with Charles, and myself had an impression of an irresistible force. It needed only one more step for us to believe that we should soon be looking down on the neighbourhood from the air, and this step was soon taken. That same day we decided to build a machine big enough to lift us off the ground. Of course, we had no idea of the innumerable difficulties we were to encounter. A monstrous Hargrave with a side of three metres gave us no results.

Construction was difficult. The cords intended to stiffen the cells stretched, our lashings slipped on the bamboo, and our surfaces, stretched as tight as we could manage over the framework, swelled like a goatskin without giving us real lift. The idea did not occur to us to join together two or three small Hargraves, like Saconnay did with his military kites.

Finally, it was a village cabinet-maker who came to our aid by teaching us the value of strong glue applied to our knots. Our structures using taut strings stopped slipping, thanks to the glue, and our struts more or less succeeded in giving us a certain rigidity. But we were still treading water, the holidays were drawing to a close and I was preparing to abandon Hargrave and his kites, when Charles suggested we made a last machine, measuring four metres. This time we replaced bamboo by spars of ash, which we could glue together.

These structures were, of course, made with no preliminary studies. In 1890 Ader had flown at Gretz in the *Eole,* and Lilienthal was flying gliders near Berlin. Jatho, Mouillard and many others had already made their tests, but we knew nothing of all this and began our aeronautical construction absolutely without documentation.

1907: Voisin biplane being handed over to an early customer, H. Kapferer.

Our ash spars were to give us the key to success by enabling us to nail our fabric surfaces to front and rear of our cells.

In cutting the spars, my brother made a mistake in the length. As we could not afford to order fresh timber, we decided to use the shorter spars as they were, so that our Hargrave was built not of cubes but of real cells joined by vertical planes.

We had feared a lack of stability, but a test reassured us completely. Then, about September 20th, after a series of experiments with similar results to our earlier ones, an unexpected event put us on the road to success.

In the Saône region, the strong regular south wind gets up about 9 or 10 in the morning, gaining force up to the end of the afternoon. Then towards five o'clock the wind drops for a while, and the clouds that have accumulated over Mâcon appear on the scene. A violent wind from the north is followed by a sharp shower, after which a cloudless sky forecasts the return of fine weather.

On this particular day, our kite was coming down into the field when the wind dropped about five o'clock. We were getting ready to take it in when the gust from the north and its attendant rain arrived. My brother took shelter under the planes of our machine, and I was about to join him when the wind suddenly increased. The idea came to me to use this air current. The kite was turned over, and my brother, still sheltering beneath the planes, raised it in front, as we usually did.

The rain had shrunk the fabric planes and stretched them tight over the spars. As the wind caught the top surface, the whole apparatus took to the air with unbelievable force, and I saw my brother lifted from the ground for a second, clutching the front cell. Then he let go, and our machine rose up as we had never seen it do before.

I decided that this success was due to the force of the wind. I brought the whole gear back to earth and tried again. I had taken my brother's place and was, like him, irresistibly lifted. We were wet to the skin but too thrilled to feel cold. Two days later the south wind rose again. As soon as it was strong enough we were out in our field. But disappointment awaited us. Our attempts to repeat our experience failed. Then Charles pointed out that our planes were loose and formed deep pockets, whereas on the earlier occasion the rain had probably given them the right tension.

I ran off to borrow a watering can and sprinkled the planes with water. The result was immediate. Our machine rose into the air. From that time on the addition of pine lathes to our surfaces gave us the permanent tension we required, and later, when our experiments turned towards gliding—incidentally, with no results—our machine had planes held in position by small cross lathes which, bending slightly under load, gave us sufficient curvature. A little later, a coat of flour paste on Mother's sheeting gave us absolutely tight surfaces. Finally, friends who had followed our efforts gave us a stack of papers describing the work of Ader, Lilienthal, Pilcher, Maxim and Chanute. Our experiments took a pseudo-scientific turn, but still produced no results in the gliding direction. We had no suitable ground and at that time had no idea of the part played by up-currents.

In 1901, I came of age and received a small inheritance from Grandfather. We were then able to organize our first workshop, in a stable. Our equipment was rudimentary, but we were enthusiastic and industrious. It was in this small shed that we built our first two automobiles and first powered aeroplane, which had not the slightest chance of leaving the ground.

Meanwhile, I had become acquainted with industrial draughtsmanship and our enterprises were generally preceded by a design study which outlined the general form of our efforts.

In 1903, I came to Paris. Colonel Renard, who knew of our work in the Lyons region, introduced me to M. Archdeacon, and I was made an engineer with the aviation association. My duties consisted of designing, building and testing everything, for the modest salary of 190 francs a month!

In five years, my technical knowledge had increased considerably. In 1900 I had seen Ader's aircraft and Ader himself, who was unfortunately too old to guide my inexperience. I knew of the work of Chanute and the Wrights, which Ferber checked minutely, and when the aviation association entrusted me with its research work, my programme was already clear in my mind.

On April 3rd, 1904, when I made my flight at Berck-sur-Mer from a favourably situated sand dune, I was well versed in this kind of experiment, and results were immediate. A year later, I built the first of all seaplanes which I successfully tried out on the Seine.

The establishment of the firm of Voisin dates from this period, and I must confess I am quite proud of a title that nobody can deny me. I am in fact the oldest aircraft manufacturer in the world, because we built not only our own machines, but also the most unexpected designs for other more or less inspired inventors, in our minute shed at Billancourt. It was here that the old Voisin model was born. This old machine

was more or less copied by hundreds of others, and its body can still be seen in the *Vampires* which now pierce the skies at around 500 m p.h.

At this period, work was difficult, because we had none of the materials we really needed. We had neither duralumin nor magnesium nor any of the wonderful steels born ten years later. Our piano wires, stretchers, assemblies, wheels, even the tyres themselves were of special design. A bicycle dealer named Colin, whose shop was opposite our workshop, made the undercarriage parts of our machines with amazing skill and ingenuity. But the feature which enabled us to make our real progress was the creation of our own design department.

From my early days with the aviation association, the drawing board had been my blessing, and it was this aspect of our work which enabled us to beat Santos-Dumont and my old associate Louis Blériot to the first kilometre over a closed circuit, which Henri Farman, one of our earliest clients, completed on January 13th, 1908.

At this time, Colliex and I were draughting first and building afterwards, whereas Santos-Dumont and Blériot were building first and drawing afterwards. Bréguet and Esnault-Pelterie also drew before they constructed, but their scientific training caused them to waste precious time. Bréguet had attacked the problem from its most difficult side, the helicopter; and Esnault-Pelterie built the whole of his machine, airframe and engines, which held back his researches.

Our machines of 1907—1908 were fitted with the *Antoinette* engine, designed by Levavasseur, and we had only to design and build the airframe, which greatly simplified our task.

During this golden age of aircraft construction, when we knew neither regulations nor official handicaps, when any inventor who wished could leave the ground without asking permission from anybody and land in any place he cared, when our welcome was always good-natured and encouraging, aircraft manufacture advanced by leaps and bounds. We were free to design and free to act, free to experiment in the most varied directions.

The French decline began in 1920, a decline which alas, was to continue, despite the desperate efforts of our best men.

The day when France again writes her name in the list of world speed records the most sanguine hopes will be permissible. To achieve this feat neither enormous funds nor sumptuous

1907: Entrance to Voisin workshops at Billancourt.

designs are necessary. One man of real quality with a handful of faithful can accomplish the miracle, but this group must have the old words of Ecclesiastes marked on their hearts:

> "Whatsoever thy hand findeth to do, do it with thy might: for there is no work, nor device, nor knowledge, nor wisdom, in the grave, whither thou goest."

A Test Pilot Reminisces

BY JOHN LANKESTER PARKER, O.B.E., F.R.Ae.S., DIRECTOR, SHORT BROTHERS & HARLAND, LTD., BELFAST, N. IRELAND

John Lankester Parker functioning as Master of the *Guild of Air Pilots and Air Navigators of the British Empire*. He was Chief Test Pilot to Short Bros. from 1918 to 1945.

A small incident, perhaps, but one of the most vivid memories of my early youth is of taking a rest on a steep railway bank when out walking with my elder brother and watching rooks circling around us. They were soaring and gliding in the gusty up-currents without apparent effort and in perfect control and seemingly without purpose other than in their own way expressing the joy of freedom and the poetry of motion. As I watched these birds a tremendous urge to emulate them came over me. In my whole experience I have never wanted to do anything so much or with the same vehemence. The logic of the reason why escapes me but I had a quite fanatical desire to fly.

From that moment I felt I understood something of the spirit behind those early pioneers, of whom Lilienthal and the Wright Brothers are the first names that come into my mind, that gave them the courage to face ridicule, the risk of injury or death and to spend their money and their energy in an attempt to do that which most people thought impossible—the achievement of controlled flight. They themselves, in their most optimistic moments, must have felt the dice were loaded against them and that they were gambling on a very long-odds chance. Of one thing I am convinced, no thought of personal fame or financial gain entered into their reckoning.

At the time of my little story about bird watching, the history of mechanical flight was already well under way, for Blériot had just succeeded in flying the Channel from France to England (July 25th, 1909) after Hubert Latham had twice so gallantly failed, causing the popular press of the day to decide that the British Isles were no longer islands in the truest sense. Less than six years had elapsed since Orville and Wilbur Wright had made their famous first four powered flights and three years since they had covered a distance exceeding 20 miles. In France Santos-Dumont had made the first flight in Europe, in England, Moore-Brabazon, A. V. Roe, Cody and others. The Short Brothers had established a factory, the first in the world devoted solely to the making of aeroplanes. In France the first Flying Meeting in the world had been held at Rheims, amidst great enthusiasm.

This account is not in any way intended to be a chronological story of events, or of their relative importance. Rather, it is to give the point of view of one who started flying ten long years after the Wrights had shown the way, who con-

Horace, one of the three Short Brothers, started to design aircraft under Wright licences in 1909. This is Short's first biplane, which flew in July, 1909. It was ordered by Frank McClean, who had induced the Short Brothers to erect Britain's first aircraft factory.

A Nieuport monoplane seaplane at Windermere in 1915. The instructor in the front seat is J. L. Parker.

tinued to serve as an active professional pilot for the next 33 years and who, to this day, is engaged in the business of aviation.

As I see it, there were four major problems facing the would-be flyers of 50 years ago: to evolve a shape that would give the necessary lifting force without an unreasonable resistance to forward motion; to find a method of controlling attitude and direction; to make the structure light in weight, yet strong enough to hold together, with only the scantiest knowledge of how or where the forces would be applied; and, by no means the least of the problems, to produce an engine that would give the necessary power with the minimum possible weight. All the time, designers were faced with the vicious circle that the more the engine weighed the greater the mass of structure needed to be to carry it, making the power requirement greater still.

Blériot's flight across the Channel was an epic, it was a courageous effort and it focussed public attention on man's new conquest, but since many flights of greater distance had already been accomplished, it had no particular significance from the purely technical point of view . . . a remark which is true also of many other world-famous achievements in aviation. The winning by Paulhan of the Daily Mail's prize for a flight from London to Manchester and Grahame-White's flight by night in a attempt to catch his rival in 1910 stick out in my mind as some of the greater events, as does the crossing of the American Continent in, be it noted, 18 days the following year.

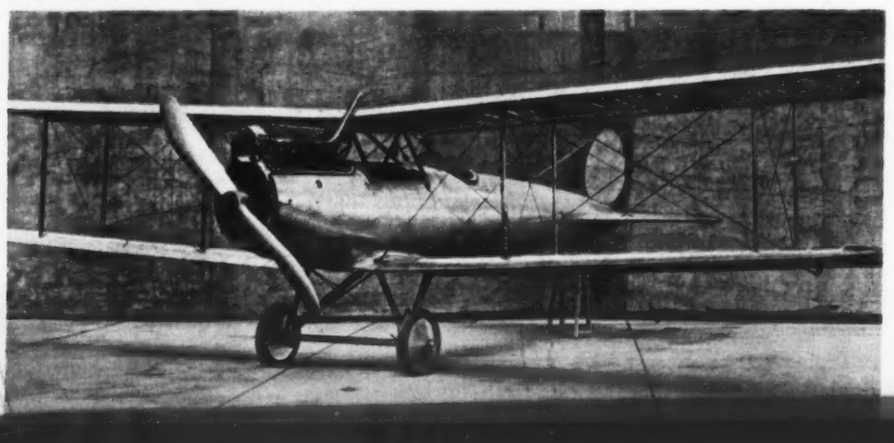
From now on aeroplanes continued to grow in size and performance. New height, distance and speed records became frequent, and seaplanes and flying-boats came into the picture. The credit for the first flight off water is generally given to a Frenchman, Henri Fabre, and the date March 1910, but the American Glenn Curtiss and a number of Englishmen—Schwann at Barrow Dock, Adams & Gnosspelius in the Lakes and the Short Brothers at Sheppey—were following close behind.

Then came the first World War and its great impact on aviation. Whereas previously money for research and experiment was noticeable mostly by its absence and development depended almost entirely on keen enthusiasts, during the war money became of little account, large and wealthy firms not previously interested in such things entered the industry, and vast numbers of aeroplanes of ever-increasing performance were made. From all of which I do not imply that no large companies were interested in aviation until the war. For example, Messrs. Vickers, to their eternal credit, had created an Aviation Department at Crayford and Brooklands several years earlier. I personally learned to fly at the Vickers School and qualified for the Royal Aero Club Certificate well before the war.

The inevitable result of all this effort was greatly to accelerate the development of military aircraft. At the end of the war some types were more nearly suited to the needs of commerce than was any existing aeroplane at the beginning, bu I hold strongly to the view that the sort of development that had taken place and the kind of world publicity (if I may use the term) it had received were by no means in the best interests of aviation as a whole.

Of all the great flights that followed, the epic, in my view, was Alcock & Brown's crossing of the Atlantic in 1919. They had to face quite incredible hazards and difficulties, not the least of which was the problem of flying in cloud by night, truly blind flying for prolonged periods, without the aid of any form of instrument except a cross level and an air speed indicator. A compass is not a blind-flying instrument, it is just an aid to navigation. I was in a better position to appreciate the difficulties of blind flying than most pilots of the time, for I had been a free-lance test pilot in partnership with an American, Clifford Prodger. We were busy, and our business and programme was continually being upset and delayed by bad weather, and so we seriously tackled the problem of climbing up through 10/10ths cloud and doing our tests and deliveries of aircraft in the fine weather above. Without wireless, turn-and-bank instruments or artificial horizon this was no easy matter. On some aircraft I think it was impossible, but on others, by various tricks such as jamming the rudder bar against the side of the fuselage with one's feet and only looking at the compass and other instruments every half minute or so, we were successful. I confess though that having climbed into cloud and, through the unexpected thickness of it, failed to reach clear air above, I never succeeded in gliding down again without getting into trouble. The changing trim as a result of closing the throttle was, under blind

The Short *Silver Streak* of 1920, the first light-alloy sheet stressed-skin type aircraft. The lessons it taught were not appreciated for several years.



Shorts pioneered water-based aircraft from 1910 onwards and built a large number of successful flying-boat types. This is the *Cockle* of 1923.

The Short "C" Class *Empire* flying-boat of 1935 revolutionized British long-distance air transportation in the pre-war years. This view shows the clean lines of the design.

During the war Shorts turned out large numbers of the *Stirling* four-engined heavy bomber.

conditions, too much for me. Many war pilots had experience of dodging into cloud to avoid the enemy and staying blind for a few minutes, but few had attempted to sustain steady flight conditions, as on a climb, for a period of say 15 minutes. And how long a minute can be: I often thought my dashboard clock had stopped.

Following on the Atlantic crossing many other history-making flights stole the headlines: to India; to the Cape; to Australia. But by far the most important event in British aviation was the start of the London—Paris Air Service by several private companies, including Air Transport & Travel led by Holt Thomas, Handley Page, Instone and Daimler Hire. Thus was British commercial aviation born. At first all the companies used converted war types carrying from 4 to 10 passengers but soon airplanes designed for the purpose came into being. By merging together, these companies formed the foundation of the great airways corporations of today. Some of the original pilots on this run are still flying—one's mind immediately thinks of the name of B.O.A.C.'s O.P. Jones—whilst many others, such as Wilcockson & Harrington, now hold executive positions of responsibility.

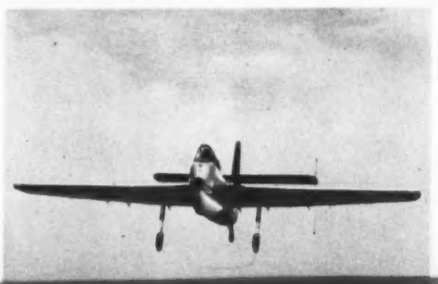
In 1920 another milestone was reached, this time a structural one, when Oswald Short created the *Silver Streak*, a single-engined biplane which was truly revolutionary. It was built of light allow sheet on what is now known as "stressed skin construction". At the time aluminimum and its alloys were frowned on by the powers-that-be as being insufficiently reliable for major stressed parts of an aircraft. However, the *Silver Streak* was impressively strong and robust, and I had the great privilege of flying it from the Isle of Grain to Farnborough where it underwent mechanical tests to destruction. At this time, Service personnel were not allowed to fly aluminium aircraft. The principle of carrying the stresses in the outer skin was not new, wooden "monocoque" fuselages there had been in plenty, and aluminium alloys had long been in demand for non-stressed parts. It was the combination of the two, a system now in almost universal use, that was Short's great contribution to aircraft construction in Great Britain. Surprisingly, the lessons of the *Silver Streak* were not fully appreciated for several years.

For my next milestone I would single out the de Havilland *Moth*, a delightful little biplane, very low in price and of quite extraordinary reliability. Produced in the middle twenties, it was the aeroplane on which a great proportion of the private flying between the wars was done and on which so many people, both civilian and service, learned to fly.

Another outstanding step in commercial air transport was the coming into service of two new aircraft of very advanced design, one of American origin and the other British. I refer to the Douglas DC-2 and DC-3 and the Short *Empire* flying-boat with which Imperial Airways built up their Empire routes in the years immediately before the war. These aircraft brought, each in its own special sphere, a completely new conception of air travel both from a performance and comfort point of view.

The second World War, like the first, caused a great boost in the development of nearly all branches of aviation. At the beginning of the war we had those fine fighting aeroplanes, the *Hurricane* and the *Spitfire*, and the *Wellington* and *Whitley* bombers. We finished with *Mosquitos, Meteors, Lancasters* and *Lincolns*. Although aeroplanes gained in size and speed and in physical numbers with increasing momentum, I think the greatest development was in power units and accessories rather than in the aircraft themselves. Whittle and his revolutionary jet propulsion came into the picture. Quite extraordinary progress was made in radio and radar research, resulting in aids to the pilot which enabled him to perform seeming miracles of navigation and skill in searching out the enemy in bad weather.

Shorts' latest operational aircraft, the *Sea Mew* anti-submarine defender, designed for low-cost production and maintenance. Shorts are engaged on a variety of research projects, as exemplified by the *Sherpa* aero-isoclinic wing aircraft.



It was after the war that the full effect began to be felt of the knowledge gained by the high pressure research and the expenditure of vast sums of money. It has culminated in this country in the present *Comet*, which is to British aviation what the *Empire* boat was in 1937.

What of the future? Great as the business of air transport is already, on the fiftieth anniversary of powered flight I believe we are only on the fringe of what it will grow into by the time we are celebrating its centenary. Possible as the result of the two wars, the primary search has always been for performance, for more speed, ever more speed—the inference being that aviation has little else to sell but speed and, by implication, that air travel is less comfortable and rather more dangerous than earthbound forms of travel and that the time saved must be substantial to make it worth while, and so on. This attitude is I think all wrong, quite the reverse of the truth. Flying by the nature of things, must be fast. An eminent designer told me only recently that he would not know how to design an aeroplane to fly the Atlantic at, say, 100 miles an hour. Yet by other standards a hundred miles an hour is good going. I think the greatest contribution aviation has to offer in the future, and the not-so-distant future, is economy.

Two major wars have naturally tended to accent the military virtue of the aircraft. Designers have been primarily concerned with the military aspect. The great majority of pilots have been trained in the military school. Today, there is no other way for the average young man to take up flying as a career. There is a tendency for private flying to become less and less common. Much as we in this country are in aviation's debt, it is a sad thought to me that development has had to be essentially military. Perhaps it is because I happen to be one of the very few who learned to fly as a civilian and followed a career as a civilian professional pilot for many years. I doubt if this would have been so had not I been attacked by polio in my childhood which, it was alleged, rendered me unfit for military service.

There is no doubt in my mind that circumstances will change and civil aviation will stand entirely on its own feet, for it has a great contribution to make towards the happiness and welfare of the world.

Roy Hardy Dobson (now Sir Roy) joined A.V. Roe in 1914 and became Works Manager in 1919.

1953 and on...

By Sir Roy H. Dobson, C.B.E., F.R.Ae.S.
Managing Director of A.V. Roe & Co. Ltd., Manchester
Director, Hawker-Siddeley Group.

Here we are with fifty years of aviation behind us. And what an amazing amount of progress has been made since the pioneers, at the start of this century, began to fashion crude flying machines. In spite of the limitations imposed by materials and engines, and above all by the lack of funds and official support, the foundations were laid for an industry which today has perhaps more influence than any other on our lives.

We have seen, in the short space of 50 years, many fluctuations in the fortunes of those who have dedicated themselves to the science of aeronautics, and it is a sobering thought that the really great advances in progress have been made due to the stimulus of warfare. Although it must be accepted that the requirements of the services lead to the most rapid advance in aircraft design, it is up to all of us to regard them as a deterrent to war and at the same time to apply our knowledge to the cause of peace.

It is a staggering thought if we try and visualize a similarly rapid progress in the next 50 years. A little over ten years ago the first practical jet-propelled aircraft made ist initial flight at Cranwell, England—this was the Gloster E.28/39. Only ten years ago the Gloster Meteor, the only Allied jet-propelled aircraft to see operational service during World War II, appeared in prototype form. How many thousands of gas-turbine-driven aircraft exist today it would be difficult to say, but there can be no doubt of the tremendous value to aviation of the work which was begun by Sir Frank Whittle in England, and brough to fruition by the Gloster aircraft company in a little village in Gloucestershire.

Fifteen years ago a maximum speed of about 350 m.p.h. was the limit of man's achievement; to-day that speed has been more than doubled in aircraft already in service with the Royal Air Force, and there are other models not yet in service capable of flying considerably faster than the speed of sound.

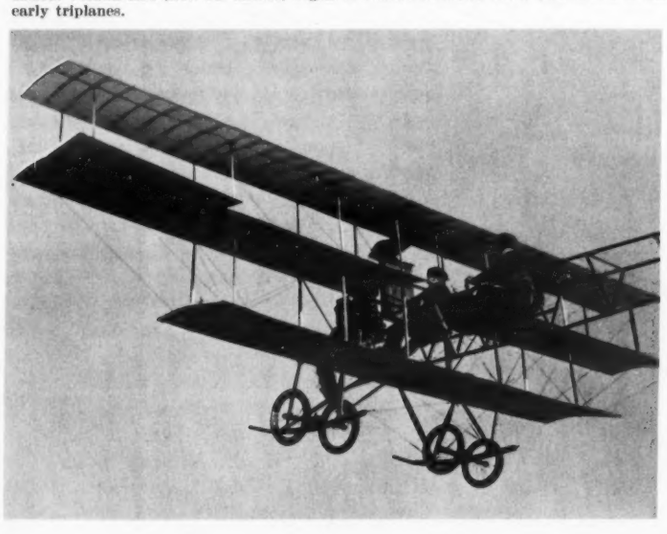
All this progress has involved, and still involves, a great deal of scientific and technical investigation and development in order to increase safely the speed and size of our aircraft and to make them more and more practical vehicles of commerce and of defence.

In spite of numerous crises and urgent demands for the near impossible this study proceeds steadily, and it is small wonder that aircraft engineers have adopted as their motto, "The difficult is done immediately, the impossible takes a little longer."

Our objective today remains unaltered. It is speed with safety and economy, and in the larger types of aircraft this means that they will be heavier and much faster than contemporary designs. By adopting the delta wing, on which my company has done so much development work, it is possible to combine greater weight with all the desirable attributes of small size and inherent safety.

From the operational point of view we and the many associated industries which deal with navigational equipment are striving to make flying independent of the weather. Fog is still the main bogey, and when we think of the cost of even a short hold-up, at the main line airport, it is obvious that there must be no slackening in our efforts to overcome this phenomenon of nature. It is no solution to build longer and longer runways and provide miles of obstruction-free approaches. This would automatically put the airports far away from the centres which they are supposed to serve, and it is up to the aircraft designers to explore, with all the zeal at their command, methods of achieving vertical take-off and landing for aircraft which have a supersonic cruising speed. Perfection in this direction will have to come and when it does we shall see undreamed-of activity at the airports of the world.

Alliott Verdon Roe (now Sir Alliott) began to build aircraft in 1908. This is one of his early triplanes.



The latest product of A. V. Roe & Co., the Avro *Vulcan* delta-wing bomber. Sir Roy Dobson says that the delta wing makes it possible to «combine greater weight with . . . small size and inherent safety."

Germany's Contribution to Aviation

BY PROFESSOR WILLY MESSERSCHMITT, MUNICH

Professor Willy Messerschmitt at his drawing board (September 1953).

Interavia has asked me to write a brief article for this commemorative issue, on Germany's contribution to the development of aviation, with particular reference to my own work in this field.

Otto Lilienthal was the first man who worked systematically on the development of gliders and experimented with them in several hundred flights. We have also to thank him for basic research results, which he wrote down in his book entitled *"Der Vogelflug als Grundlage der Fliegekunst"* (Bird Flight as Basis fo Aviation). He was building his first powered aircraft in 1896 when he was killed during a gliding flight. A few years later, the Wright Brothers, inspired by these experiments, began their work on gliders, gradually improving them. When they had succeeded in making gliding flights over several hundred yards, with full control, they ventured on the construction of a powered aircraft. On December 17th, 1903 they successfully made four real powered flights.

In all civilized countries there were men who tried to emulate the Wright Brothers. In Germany, there were Grade, Etrich, Euler, Rumpler, the Dutchman Fokker, and later Junkers and a number of others. At this time I was still a schoolboy, and the only way in which I could express my enthusiasm for aviation was to build model aircraft. It was through this activity that in 1910 I got to know Harth, who was making gliding flights near Bamberg, with the idea of going on to soaring flight. I became his most industrious pupil, first in construction, then in design, and in 1913 I was allowed to make my first glider flight. During World War I and immediately afterwards Harth and I built several gliders together. In one of them he succeeded in 1921 in carrying out a flight lasting 21 minutes, a performance which marked a transition from gliding to soaring flight. However, I was anxious to use for purposes of powered flight the experience I had by then collected. This led to our separating, on the most friendly terms. In 1923 I founded–though still a student at Munich Technical University–an aircraft workshop in competition with the already internationally known firms of Junkers, Dornier, Heinkel and several smaller ones.

As the years progressed, a great number of types was produced, with a constantly growing staff: sports aircraft, touring and commercial aircraft of wood, steel tubing or light metal. Many of these aircraft won first prizes in national and international contests. The M 18, my first all-metal transport aircraft, thanks to its economy in operation, did much to keep one of the newly-established airlines alive. The Me 108 *Taifun* was built in hundreds and flown throughout the world as a touring aircraft. The Me 109, designed 18 years ago, led the way to modern fighter design, and a special version of it won the absolute world speed record in 1939. This is still, 14 years later, the class record for propeller-driven aircraft of all kinds.

The recognition of the fact that no further speed increases could be obtained with the piston engine-propeller combination led to the development of jet propelled aircraft in Germany and Britain. In 1938 I began work on the project for the Me 262 turbojet fighter, which became famous by the end of World War II. The prototype was flown with a piston engine in 1939, made its first jet-powered flights in 1941 and by 1942 had reached the production stage. However, it was not until the end of 1943 that it aroused sufficient interest for quantity production to be prepared in earnest. With standard engines this aircraft had a speed of 540 m.p.h., though a special version with a more powerful engine flew faster than 620 m.p.h. by the end of the war.

My interest in tailless aircraft led me to work with Lippisch, who had been experimenting in this field for many years. The result was the Me 163 interceptor. At the suggestion of Wernher von Braun, I had a rocket engine fitted in this aircraft, with which it reached a speed of 665 m.p.h. in an official test in 1942.

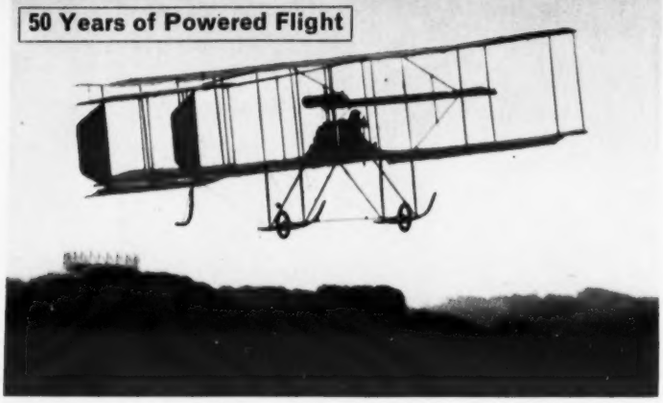
In addition, my factories produced aircraft capable of carrying very heavy loads, such as the six-engined Me 323 which had a gross weight of 110,000 lbs. and a four-engined aircraft with an absolute range of fifteen thousand kilometres (9,300 miles). We worked on many other ideas as well, and these are common property today. I would mention only the single-spar metal wing, the cantilever undercarriage, the first use of reversible-pitch propellers for braking purposes. Our research work on swept wings led to similar experiments with propellers, with the object of increasing their efficiency at high speeds. It is beyond the scope of this article to name all these inventions and discoveries.

What I have said above on my personal contribution to the development of aviation may be taken as an example of the overall German contribution. It is not my place to report on the work of the others who worked on the same tasks before and alongside me in Germany, in friendly co-operation or fruitful competition. Nevertheless, I should like to mention some of the names which have gone down in international aviation history: Junkers, as the builder of the first metal aircraft, the first practicable airliners and the Diesel engine for aircraft; Dornier, for the creation of his famous flying boats; Heinkel, as the designer of the first high-speed commercial transport and initiator of jet development; Focke, for his successful helicopter designs. And lastly, the most shining light in German aeronautical science, the unforgettable Prandtl.

1924: The two-seat Messerschmitt M 17 was powered by a 25 h.p. engine; gross weight 795 lbs; load 400 lbs.; max. speed 80 m.p.h.

1944: Messerschmitt Me 262 single-seat fighter with two Jumo 004 B turbojets of 1,980 lbs thrust each; gross weight 15,600 lbs; max. speed 540 m.p.h.

50 Years of Powered Flight



1911: Ernst Heinkel's first aircraft (with 50 h. p. Daimler engine) over Cannstätter Wasen.

Memories of a Designer

BY PROFESSOR ERNST HEINKEL, STUTTGART

Fifty years ago the Wright Brothers, beginning at the turn of the century with glider flights and after studying the experiments of Lilienthal and others, made the first practical powered flights over the sand dunes of Kitty Hawk. Their success was due in part to the work of a number of German inventors, such as Otto, Benz and Daimler; it would not have been possible without the light internal-combustion engine.

The significance of powered flight was not recognized in Germany till much later. After the death of Lilienthal almost twelve years passed without any further experimental activity. At that time German enthusiasm was concentrated on airships, particularly the work of Count Zeppelin.

It was not until the introduction of the Lanz Prize in 1908 that actual development of powered flying began in Germany. The prize encouraged designers to complete what the German pioneer Karl Jatho had begun. The same year Hans Grade succeeded in making a first hop in a machine he had made himself, and a year later he won the Lanz Prize. His success gave flying in Germany a tremendous impetus and aroused growing interest in aviation throughout the nation.

I, too, was one of the enthusiasts of that time and built an aircraft of my own, in which I had a serious accident in 1911. Despite this setback I determined to continue working on heavier-than-air machines, and I am happy that I have been given a chance in the forty years since then and from the most modest beginnings of putting this determination into practice.

When the foundations of a German aircraft industry were laid in 1912 I left the technical university to engage in design. In 1913, working for Albatros, I built the first amphibian, a monoplane with a 100 h. p. Benz engine, which had both wheels and floats. In this aircraft Hellmuth Hirth emerged as victor from the Lake Constance Flying Week in 1913 and the seaplane contest held the same year on the Italian lakes. Later I designed seaplanes for Hansa-Brandenburg.

After World War I flying in most countries was dominated by the military, whereas in Germany the restrictions of the Versailles Treaty provided an impetus for sports and commercial flying. While Dr. Hanns Klemm created a whole series of low-powered light aircraft for sports pilots, Prof. Junkers was above all working on commercial types. In 1919 he built the F 13, the first all-metal airliner in the world, and thus led the way to modern aircraft manufacture. His designs were acclaimed and bought throughout the world, though Dr. Dornier and Rohrbach also did pioneering work in all-metal aircraft construction. Looking back, it can be said that the Lufthansa's world reputation was built not only on its excellent organization and efficient crews, but also on these pioneer achievements by German designers.

Here I may mention my catapult system, which enabled aircraft to take off from ships at sea (or with overload from airfields). The Lufthansa took up this design and had Norddeutsche Lloyd equip its flag ship, the S.S. *Bremen,* with a catapult in 1929.

When faster and faster airliners were required my firm produced the project for the Heinkel *Blitz* (He 70) with retractable undercarriage, in 1931. This type, an aerodynamically advanced design of monocoque construction, attracted the attention of the aviation world not only because of its shape but also because of its outstanding performance. Several international records (with payloads of 500 and 1,000 kg over a distance of 1,000 km) were won for Germany by this aircraft. The He 70 was then developed into the He 111 twin-engined airliner, which later was built in large numbers as a bomber.

It was only after 1933 that German aviation was freed of all restrictions. This was followed by intensive development in all branches of aeronautical engineering and by a mighty expansion in the aircraft industry. New aircraft types were brought out in rapid succession. For example, my firm produced the first turbine-powered aircraft, the He 178, and then the He 176, which was powered by a liquid-propellant rocket. Here the rocket was used not only as a take-off aid but for sustained flight. The two designs introduced a new era in the history of flying.

Once again war became the instructor. It confronted the German aircraft industry with a host of new problems, in the solution of which new ground had frequently to be broken: cargo gliders, large transports, jet fighters, rocket aircraft, anti-aircraft rockets, etc. — A special word should be said of Dr. Alexander Lippisch, who developed the "tailless" Me 163 for Messerschmitt AG, the predecessor of today's delta-wing aircraft, and fitted it with a Walter bi-propellant rocket engine. Professor Messerschmitt created the Me 262 jet fighter fitted with two Junkers Jumo 004 turbojets. I myself worked on the He 162, a stripped, low-cost jet fighter, which showed the way towards the short-life aircraft.

Germany's past achievements justify the hope that German engineering and industry will one day again be able to make their contribution to the progress of aviation. The West, too, must surely realize that a people cannot permanently do without its own aircraft industry.

1944: Heinkel He 162 interceptor – the "People's Fighter" – with BMW 003 A-1 turbojet of 1,760 lbs. thrust; max. speed 520 m.p.h.

Heinkel He 70 *Blitz* high-speed commercial aircraft (with 650 h.p. BMW engine) for four passengers and two crew. Max. speed 225 m.p.h.

The Weapons System — A New Concept in Aircraft Production

BY LT. COL. PIERRE M. GALLOIS, PARIS

The continuing trend towards higher and higher performance of flying equipment is leading to greater and greater specialization in aircraft. Operational requirements, on the other hand, are becoming so demanding that man is being taxed to the limits of his faculties. Equipment, too, is being pushed to the extremes of its capabilities.

These two factors, specialization of equipment and virtual elimination of the leeway that has hitherto existed between the performance demanded by the air arm and the limits of physiological and technical endurance have recently led to a new concept referred to by the general term "integrated weapons system" and applied indifferently to the problems of production and to operational questions.

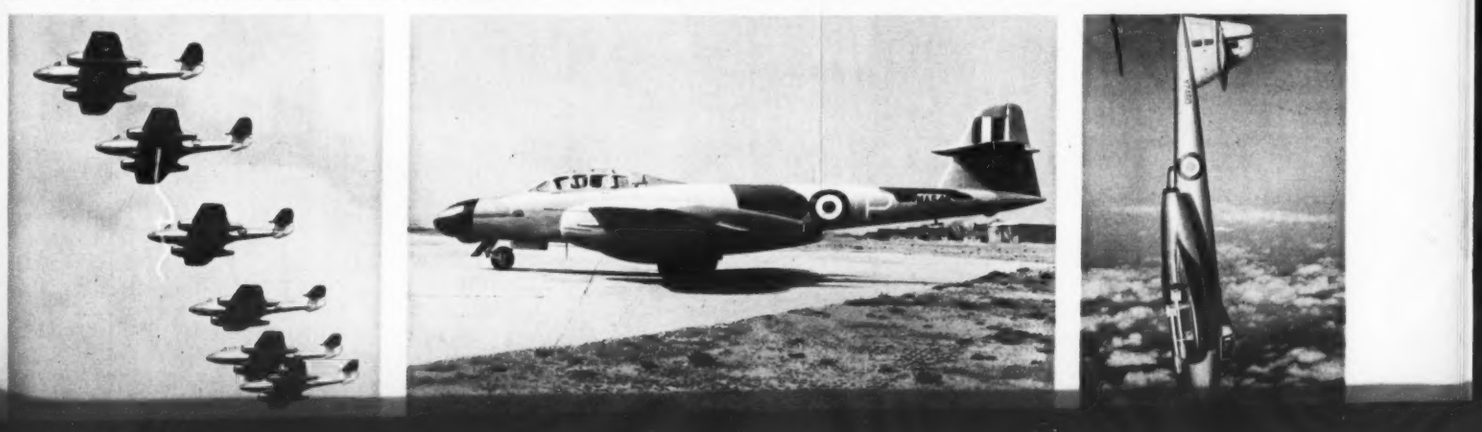
At the end of the last war, before the full resources of jet propulsion had been explored, it was regarded as sufficient to have a single basic fighter type to accomplish such varied tasks as aerial combat (interception over longer or shorter distances, escort, day or night missions, etc.) and destruction on the ground (denial, engagement, support, etc. . . .). The Lockheed F-80 *Shooting Star* and later the North American F-86 *Sabre* in the United States, the Gloster *Meteor* and the de Havilland *Vampire,* followed by the Vickers-Supermarine *Swift* and the Hawker *Hunter* in Britain, were expected to cover this vast range of operations. Since then it has been necessary, in order to meet increasingly vast and detailed operational requirements, to develop a whole series of equipment specially suited to the wide scope of new missions.

The new concept of air "vocations" proper to each country accentuates still further this necessity. Each nation has its own problems which depend on its position on the map, its system of alliances and the nature of its potential enemy, its economy, climate and terrain and, to a certain degree, on the psychology of its population. Since the advent of flying and in pace with its development, the United States has become more and more closely linked with events in the Old World. The distance separating it from its advanced front line, and from the sources of power of its potential adversary has rendered the problem of range of first importance. American engineers, called upon to reconcile two aspects of performance as technically incompatible as range and rate of climb, have weighted their choice in favour of the first at the expense of the second and designed fighters to do double duty as interceptors and bomber escorts. It is only since 1949 that the problem of short-range defence has begun to figure in their programmes and that aircraft have been specially designed for this purpose (the F-103, an interceptor derived from the Republic XF-91, has only recently been ordered into production).

Hitler's Germany, on the other hand, placed in very different conditions and with its skies virtually invested, developed machines with an almost vertical climb–the Me 163, for example–which represented the other extreme in the range of interceptors at the time.

Every year visitors to Farnborough see numerous prototypes of naval strike and anti-submarine aircraft. This is because, for Great Britain, the war at sea plays just as important a part as destruction on the ground for continental powers. In Russia, because of the tremendous expanse of her territory, the Soviet air defence command has given the defence of vulnerable points priority over general cover. In the Russian case, therefore, the classic compromise between the two opposing sets of performance has inclined towards rate of climb, at the expense of range. As its prime mission is to intercept bombers penetrating deep into Russian-held territory rather than to engage in combat with other fighters, the MiG-15 has been armed with cannon, whereas the *Sabre,* designed primarily for other duties, was equipped with a larger number of smaller-calibre weapons. Similarly, Germany and Russia, both continental powers engaged in a combined land and air war, had equipped themselves with the *Stuka* and the *Stormovik* respectively, to meet the requirements of the strategy imposed on them by the nature of their theatre of operations. These aircraft were not suitable for other tasks, as was evidenced by the failure of the *Stukas* and of the Germans' light and medium bombers in the Battle of Britain. Today, while countries separated from a potential adversary by geographical distance or, better still, by a natural defence in the form of a stretch of water, are seeking to develop an interceptor fighter force capable of operating in all weathers and mounting permanent guard in their skies, continental countries should equip themselves with the means of destroying the enemy on the ground over short or long range, again in all weathers. It is just as important to these continental countries that such air activities should be continuous as it is for the others to destroy enemy aircraft in flight. Admittedly the problems set the engineers by such equipment are more difficult to solve, but militarily it is just as vital, if not more so. Much has been written, too, on the vulnerability of the ground organization required for existing ground attack equipment. Here too, it is obvious that insufficient attention has been given to the notion of adapting equipment to the needs of the operational theatre. The inordinate increase in means of destruction also adds to the vulnerability of extensive static installations near the potential enemy. The search has therefore begun for new equipment which would not need such vast installations and would thus be, partially at any rate, free from this threat. And in this search we are led once more to swing the inevitable technical compromise towards capacity to perform a given mission well, at the cost of possible unsuitability for other purposes.

Old practice: One basic design was adapted to cover such varied tasks as day and night interception, escort and ground attack. *Left,* Gloster *Meteor 4* day interceptor version. *Centre, Meteor N.F. 11* for night operations. *Right, Meteor 8,* with rocked projectiles, the ground attack model. (Photos: British Crown copyright.)



New concept: specialization is the order of the day. *Left,* North American F-100 *Super Sabre* high-speed interceptor, combining supersonic speeds at combat altitude with extremely high rate of climb, but of relatively short range. *Right,* Northrop F-89 *Scorpion* all-weather fighter with wing-tip rocket launchers on a long-range mission over Alaska.

Thus, as the variety of air force missions increases, we are forced to greater and greater specialization. In turn, since the other side solves the same problem in the same way, the only means of attaining superiority in a given sector is by still further specialization. It is becoming less and less satisfactory to use different versions of the same machine to cover the whole scale of missions. Moreover, it is becoming more and more difficult to make accessories and equipment interchangeable without jeopardizing operational efficiency. In both general design and detail, technical specialization is becoming imperative, as its military advantages outweigh the obvious industrial and economic drawbacks.

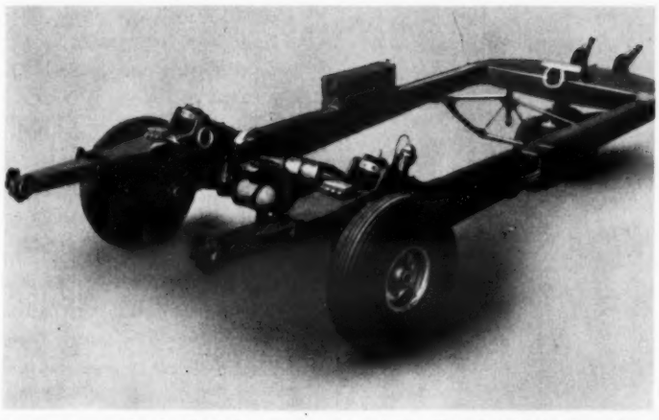
The exact adaptation of an aircraft to the mission it is to fulfil and the specialization of armament and, in more general terms, of all its equipment, demands the adoption and application of the concept of weapons system management in its widest sense. On the national level this mean basing flying equipment programmes on a detailed study of the weapons system most suited to the country in question. It means working out the characteristics of aircraft or missiles capable of covering the whole scale of missions which the country's forces are called upon to perform, taking into account all that country's given constants (nature of theatre, economy, industry, psychology of its forces, etc.) and all available information on the enemy's weapons system. On the technical and industrial level, where the term weapons system has a much narrower sense, it means organizing production around the principal designer, as in the current U. S. Air Force experiment. It also means eliminating the Government as an intermediary between the military—or civil—user and the designer, the latter being made responsible for meeting the specifications provided by the user, without the Government insisting on a given method of propulsion or the utilization of specified equipment. As is known, General Donald L. Putt, head of the U.S. Air Force's Air Research and Development Command, has organized such a system in the United States. He found ample justification for the move in the growing complexity of equipment and accessories, which makes it impossible for Air Materiel Command to go on playing its present role of equipment and accessory supplier. Another reason was the desire to obtain maximum operational efficiency, without Government agencies–which at present play the part of co-ordinators and partial suppliers–placing any obstacle in the way of designer and manufacturer in their struggle to bend their raw materials to the Air Force's needs.

New concept: Britain's position as an island necessitates special attention to anti-submarine operations, shore-based and carrier-based, or for convoy protection.

From runway to proximity fuse

A rational solution to the problems of working out procurement programmes, of placing orders and organizing production, the weapons system is even more valuable when it comes to designing a definite model to give the best possible performance on a given mission. In

Above, Avro *Shackleton Mk. 2* (long range, land-based); *bellow left,* Fairey *Gannet* (medium range, carrier-based); *right,* Short *Sea Mew* (low-cost medium range, escort-carrier-based).



European example of a limited weapons system is the French SE 5000 *Baroudeur* (right) tactical aircraft designed to operate from primitive airstrips, with its take-off trolley (left). The same trolley is used for recovery of the aircraft, which lands on skids. Both units were designed in concert.

order to improve performance and reach superiority in a single sector—an ever narrowing one—the designer has to regard his machine as one of the links in a chain of equipment designed as a whole to obtain a given result rather than as a master machine, with perhaps auxiliaries or specifications to which he may or may not adhere. In addition he must demand so much of each of the elements of his flying machine that he seeks to relieve it of as much load as possible, so as to integrate it even more thoroughly in a weapons system.

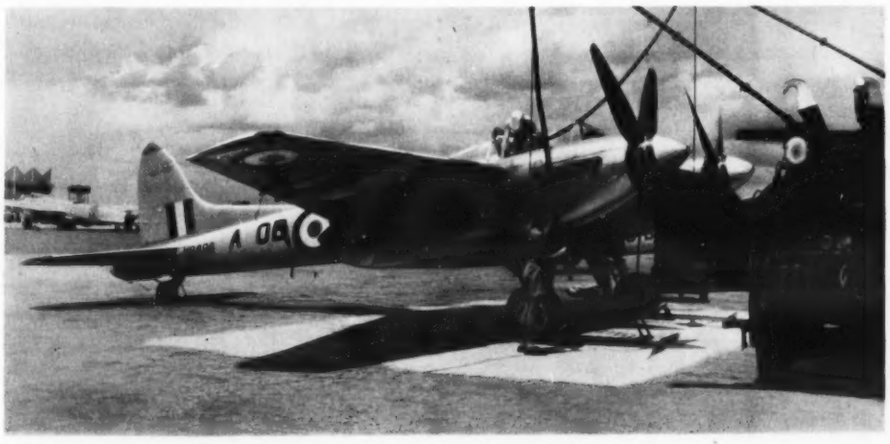
Let us take the example of the S.N.C.A. du Sud-Est SE 5000 *Baroudeur*. Its design has been based on the desire to give the tactical air units operating on the continent a combat vehicle which would be independent of the long concrete runways required for existing fighter-bombers. The vulnerability and cost of present-day airfields and the static nature of operations based on them were so many fetters which had to be broken. Without realizing it, the design office, charged with finding a new solution, drew up its project within the framework of a weapons system. The value of the design lies in the results obtained through the combination of an aircraft without wheels and a take-off trolley. As it happened, the aircraft itself took second place in the design studies, and the trolley had to be given priority because of the uncertainty of how it would function. But the weapons system would be incomplete if it were limited to the aircraft-trolley combination. What concerns the user is not only that he can utilize small runways or make-shift airstrips, but also that he has a combat instrument that is mobile as regards its ground installations, efficient in its performance in flight, that is, powerfully armed and suitably equipped for detecting its target and attacking it with the maximum efficiency. Regarded in this way, the weapons system is identical with the tactical mission to be filled. It covers not only the aircraft itself with its armament, navigation and target identification equipment, but also the ground apparatus used for take-off, recovery, refuelling—if it requires special conditions—and the movement on the ground of the installations required. The "aircraft" design office is called upon to abandon its classic role, now that it has become master of the mission and not merely of the machine, which is now no more than one of the elements enabling the mission to be accomplished. This competence has been extended to all elements of the project. This new concept would have the advantage of ensuring harmony between the various resources to be employed to provide the combatant with a complete instrument, designed as a coherent unit and regarded operationally as a whole. The prime contractor does not himself have to design the armament, navigation equipment or metal runway, if required, but he must be able to incorporate freely into his design the components which he needs in order to get the most out of his product. In a word, he must be responsible for the perfect cohesion of the whole.

The tactical weapons system thus obtained must in turn be incorporated in a vaster system, which this time concerns other prime contractors than the manufacturer of flying equipment and its direct auxiliaries. For example, the aircraft must be capable of integration into the communications system planned for the theatre, a system which may vary according to conditions of climate and especially of topography. In the mountainous country of Korea, for instance, air crews frequently had considerable difficulty in communicating with paratroops, whose VHF signals were often masked by the mountains: their transmitters were too heavy and too bulky to be carried to sufficiently open spots.

Similarly, it is probable that, when Glenn L. Martin's engineers designed the *Matador*, they found themselves obliged to incorporate the missile itself with its power plants, warhead and stabilization equipment, into a much larger system extending from the launching apparatus, through the take-off booster rocket and special supply organization required, to the guidance equipment.

On a still higher level of weapons systems, there are the long-range atomic task forces of tomorrow. These task forces will probably comprise not only A-bomb carriers but also missile interceptors and anti-jamming aircraft. If flights are to be made over very long ranges, tanker aircraft will be added to the offensive task force,

The weapons system concept extends to all equipment involved in a given mission. Refuelling equipment is one of the most important items. – A de Havilland *Hornet* long-range fighter-bomber refuelling at R.A.F. Station, Tengah, Sinzapore. (Photo: British Crown Copyright.)



Other important elements in a complete weapons system are ground radar services and communications. Pictures show a radar plotting screen and control tower installations "somewhere in Alaska".

so as to form a vast aerial whole, to be designed, produced and operated within the framework of an imposing weapons system.

Very little is known about Boeing's pilotless interceptors, the XF-99, but it may safely be wagered that they were designed as missile-carriers, around the potentialities of the missiles they are to carry and around the characteristics of the detection and guidance system. Here the notion, advanced above, of a long chain of varying equipment, beginning in the bunker where interception details are worked out and ending near or on the target, takes on its full meaning. The selected aerial vehicle is closely integrated with the whole. The virtues it possesses must be complementary to those of the missile—or missiles—which it launches against its air target, and of the radar and other guidance aids employed. In this case, the classic air vehicle is developing more and more towards the role of intermediary. Here, freed of the presence of man on board, it has reduced its weight both by the impedimenta which had burdened and complicated it and by the equipment which it can leave on the ground, since the ground has taken over the functions of guidance and recovery.

If the interceptor of tomorrow is still piloted, this will be because the complete ground-to-air missile will continue to be subject to limitations for some time to come and because jamming can divert it from its path or neutralize it before it reaches its target. The piloted interceptor, responsible for carrying the missile or aerial torpedo to within range of the enemy, becomes a flying machine with limited tasks but high performance. It may even be designed solely to lift into the air the weapons of destruction it carries, the pilot being responsible for supervising its trajectory and the equipment required for the outward journey, for aiming and returning. As this equipment and this airframe are costly, man is needed to bring them back to earth for a new mission. It would seem to be very difficult to design such a machine, with relatively restricted freedom of manœuvre, without incorporating it in an interception weapons system which extends from detection to the missile or torpedo it releases, via the ramp or take-off and recovery site and via the guidance system designed to direct it towards its target. If ground radar is one of the means of guidance used, the narrowness and range of the beam will decide both aircraft and missile performance. Conversely, if the missile has high-precision automatic controls, less will be demanded of the carrier aircraft and the equipment indicating the trajectory it shall follow. The weapons system will also encompass the problems of take-off (ramps, catapults or small fields) and recovery of the aircraft once its "ascent" is complete. In these conditions any attempt to produce an isolated project for a machine to fill such a role would be doomed to failure, so closely interdependent are the various elements in this weapons system. The equipment produced would be handicapped by duplication if, for lack of cohesion and overall vision in the design of a project, the links in the chain overlapped or if full advantage were not taken of the operational potentialities of each of them.

The aircraft manufacturer, king pin in the weapons system

Consideration of these new operational requirements brings us back to General Putt's technical difficulties. If Air Materiel Command can no longer carry the burden of supplying the principal contractor with certain equipment, neither can the latter think out his design without incorporating in it other branches of production of which he must have full knowledge.

The aircraft industry would need to be reorganized to meet the new requirements, and would take on a different structure from what it has today in most countries.

The chief factor in technical and industrial development of the past two or three years is undeniably the growing part played by accessories and equipment.

Though not yet extensive, this shift of the industrial apparatus towards new propulsion systems, electronics and accessories has taken place to the detriment of the part usually occupied by the airframe. In most cases a new branch has developed alongside the old one. But this, at any rate in the field of military research and production, is a temporary situation, and the shift will gather speed as technical evolution advances, becoming a landslide once fully satisfactory missiles are available in numbers.

The cost of flying equipment has increased to such an extent that in many cases the only way to keep within budgets—even those that were at one time quite adequate—is greatly to reduce the number of aircraft built. The increase in cost no longer falls on the same sector of industry as before; in large measure it is the new branch of accessories and equipment which benefits. The airframe manufacturer will find himself thrown from the pedestal from which he has hitherto dominated the aircraft industry, and relegated to the ranks of other suppliers. In tomorrow's chain of weapons systems he will design and produce a link whose role is essential but which may be of mere secondary importance from the point of view of the engineering developments it incorporates and the man-hours it requires. Later, unless he himself advances, he will be reduced to simple tin bashing.

The weapons system concept gives him just this opportunity for evolution. If the aircraft manufacturer becomes the prime contractor of tomorrow's weapons system and if, in conjunction with the user, he designs a given weapons system, he will regain a leading place by co-ordinating design and production of all elements making up the weapons system.

An experiment with the design and manufacture of an aircraft which can still be classified as conventional is now being conducted in the United States. Consolidated Vultee have received an order from the U.S. Air force for a supersonic bomber to be produced under the Weapons System Management concept. "This is the way the Wright Brothers worked," the company's Vice-President A. C. Esenwein remarked humorously, "as they supplied their machines complete and also provided the engines." Tomorrow the contract may contain no specifications other than the combat mission to be filled, and the prime contractor will have to provide the rest.

What's in the Air ? *

AVIATION POLITICS

● European personnel policy at N.A.T.O. Headquarters

Headquarters of Allied Air Forces, Central Europe, Fontainebleau, have been reorganized, and for the first time American officers do not predominate in the top-ranking posts. British nationals hold four posts, in addition to that of Air Chief Marshal Sir Basil Embry, AAFCE Commander, while the United States has only two. France and Canada also hold two leading posts each, and Holland one.

● Holland-Indonesia air transport talks

The Indonesian Government has appointed a special commission, to which officials of the Ministries of Foreign Affairs, Education and Finance belong, to examine the question of the renewal of the traffic agreement between Garuda Indonesian Airways and KLM. An Indonesian delegation is to go to The Hague in December for talks with the Dutch air transport authorities and with KLM. The question is urgent, since nationalization of Garuda is planned. Under existing agreements KLM will continue to have an interest in Indonesian air transport until 1960, i.e., until Garuda becomes economically and technically independent.

● I.C.A.O. Air Lexicon in Spanish

The International Civil Aviation Organization has now published a Spanish edition of its air lexicon, which appeared in English in April 1952. Spanish title is " Lexico de términos usados en aviación." The book contains about 3.000 Spanish expressions and their English and French equivalents, in some cases with brief comments.

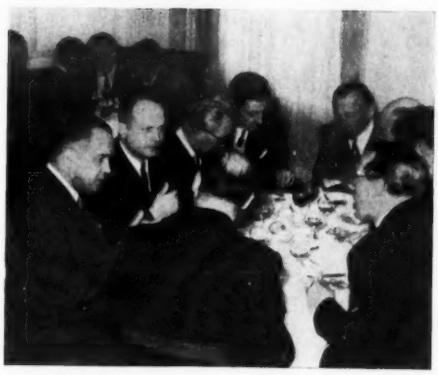
● Dr. M. Burkhard—Director of Swiss Federal Air Office

Dr. Markus Burkhard, Colonel in the Swiss Air Force, is to take over the office of Director of the Swiss Federal Air Office at the beginning of 1954, as the present Director, Colonel Louis Clerc, has reached retiring age. Dr. Burkhard, who has been a member of the Swiss aviation authority since 1934 and Vice-Director since 1948, compiled a report on civil aviation—submitted to the Swiss Parliament early in 1953—which will doubtless play a decisive part in future Swiss air transport policy.

SERVICE AVIATION

● 12th U.S. Air Force in Landstuhl

Major General Dean C. Strother, Commanding General of the United States 12th Air Force, has moved his headquarters from Wiesbaden to the new base at Landstuhl-Ramstein, near Kaiserslautern, 25 miles from the French border. The creation of a new command headquarters for the U.S. Air Force's tactical units stationed in France and Germany is designed to improve coordination between N.A.T.O.'s Central Europe air forces.



Geneva meeting of the International Association of Aircraft Manufacturers (Association Internationale des Constructeurs de Matériel Aéronautique). At Interavia's cocktail party, Hôtel des Bergues. *a)* Left to right (facing camera) : H.F. Alioth, Manager of the Swiss Pilatus Works ; Georges Héreil, A.I.C.M.A.'s Chairman and Managing Director of S.N.C.A.S.E. ; (fifth from left) Director Kastner, Düsseldorf ; (back to camera) : Herr Friedmann, Bonn ; Prof. Leo Brandt, Düsseldorf.

b) Left to right : Maurice Heurteux, Chairman of Hispano Suiza and Chairman of the Association of French Aircraft Manufacturers ; Charles Dechevrens, Chairman of the Swiss Industries Association (A.I.S.A.) ; Engineer General Mazer of the French Air Ministry ; M^me^ Dechevrens ; Divisional Colonel Etienne Primault, Commander-in-Chief of the Swiss Air Force.

● Heligoland replaced as bombing target

The Royal Air Force has been using the Grosse Knechtsand—5 miles off the coast of Bremerhaven and Kuxhaven—as bombing target since the middle of November. The Grosse Knechtsand, which has never been inhabited, has replaced Heligoland.

● R.A.F. studying Swedish landing procedure

The R.A.F. has sent a group of specialists and two Armstrong-Whitworth N.F.1 night fighters (Glosters) to Sweden to investigate a new Swedish radar landing procedure.

AIR TRANSPORTATION

● Threat of rate war averted

The International Air Transport Association's Traffic Conferences, meeting in Hawaii, have succeeded in averting the threat of a " rate war " in Atlantic cargo traffic, which would undoubtedly have led to a complete breakdown of the existing rate structure. The Conference arrived at a rate agreement valid until March 31st, 1955, which retains the present basic rate ($2.42 per kg between New York and London) and the 25 % reduction for consignments of more than 45 kg. It also agreed that, for a trial period of twelve months from April 1st, 1954, a rebate of 30 % shall be given for shipments of over 200 kg. The number of members of the I.A.T.A. Rate Boards has been raised from five to eleven : Air France, B.O.A.C., El-Al, K.L.M., L.A.I., P.A.A., Sabena, S.A.S., Swissair, T.C.A. and T.W.A.

● Scheduled flights using jet streams

Pan American World Airways have opened the first services on the Tokyo-Honolulu route using jet streams. These are west-east air streams at three to five miles above the Pacific, which increase aircraft speeds in this direction by 80 to 100 m.p.h. With their aid flying time between Tokyo and Honolulu can be cut by about seven hours.

● Bids for Saro Princess

For years B.O.A.C. has been maintaining that operation of the 140-ton ten-engined Saunders-Roe SR/45 *Princess* flying boat would not be profitable. Now that the Bristol *Proteus 3* propeller turbine appears to be in sight, interest in this flying boat has revived. At any rate a B.O.A.C. spokesman has stated that the Corporation would be willing to cooperate with the Ministry of Supply and the makers in the development and operation of the *Princess*. Quite independently, however, Aquila Airways Ltd., one of Britain's most active private air carriers, has made the Ministry of Supply an offer for all three *Princesses*. The offer also throws light on the growing economic strength of British charter companies, which have previously had to make do with B.O.A.C. and B.E.A. cast-off aircraft (such as *Vikings*, DC-3s, etc.).

● International Aeradio in Yugoslavia

International Aeradio Ltd., British firm specializing in organizing air traffic control and ground services, has received a contract from the Yugoslav air authorities to supply radio stations for the airports of Belgrade, Zagreb and Skoplje, including VHF equipment.

At the International Air Transport Association's Ninth Annual General Meeting in Montreal. Left to right : Sir William P. Hildred, Secretary General of I.A.T.A., with three I.A.T.A. Presidents : G.R. McGregor (T.C.A.) 1953-54 ; Max Hymans (Air France) 1954-55 ; Dr. Walter Berchtold (Swissair) 1952-53.

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After the signing of the U.S.-Spanish bases agreement, United States Secretary of the Air Force Harold E. Talbott paid a visit to Madrid for talks with the Spanish Government. Inspecting the guard of honour at Madrid-Barajas airport.

● **Luftag increases capital**

On November 16th an Extraordinary General Meeting of AG. für Luftverkehrsbedarf (Luftag, forerunner of the Deutsche Lufthansa) decided that its capital should be increased from DM 6,000,000 to DM 25,000,000, with the Federal Government providing the majority of the extra funds, and that the Board should be enlarged by coopting Dr. Max Adenauer (son of the Federal Chancellor).

INDUSTRY

● **Higher sales but lower profits**

The Aircraft Industries Association of America reports that total sales of aircraft and propellers for the first half of 1953 amounted to $4,200,000,000, compared with $2,900,000,000 during the corresponding period last year. The Association also states with some concern that despite this substantial increase in turn-over there was no increase in net profits. It may be recalled that the twelve major airframe manufacturers, who between them supply 90 % of all aircraft, made a profit of only 2.2 % of their sales in 1952. A survey of 1,783 industrial undertakings in all branches of production made by the National City Bank of New York shows that American industry on the whole works on a profit margin of 5.4 %.

● **No rule without exception . . .**

Fairchild Engine & Airplane Corp. reports a net profit of $3,486,000 for the period January to September 1953, compared with $1,887,000 for the same period last year. This is equivalent to $1.50 per share ($0.81) on 2,310,207 outstanding shares. Sales : $128,874,000 ($83,168,000).

● **Hark, hark, the lark . . .**

Speaking at a banquet given by S.N.C.A. du Sud-Est and Société des Moteurs Salmson in honour of Test Pilot Jean Boulet (who set up six world records in the SE 3120 *Alouette*–Lark, during the Paris Air Show), Georges Héreil, Chairman and Managing Director of S.N.C.A.S.E. stated that it should be possible, by investing 350,000,000 francs, to produce the *Alouette* at an internationally competitive price and to get orders for more than 100 of them. In his reply French Air Minister Louis Christiaens said that the *Alouette* would probably be the first French helicopter to be built in quantity.

Designer and pilots of the Leduc 021 experimental ramjet aircraft. Left to right : Test Pilot Littolf, Engineer René Leduc, Test Pilot Sarrail.

AIRCRAFT

● The XF-102 prototype of the *Convair F-102* delta interceptor now in production crashed on November 2nd, shortly after take-off. Neither the U.S. Air Force nor Convair have as yet disclosed the exact causes of the accident, but it is assumed that the immediate cause was an engine defect. The XF-102 prototype began flight testing on October 24th. A second prototype is expected to be ready for flight testing before the end of the year.

● Flight testing of the *Leduc 021* experimental ramjet aircraft is continuing. Engineer R. Leduc expects the machine to obtain a rate of climb of 39,300 ft/min near the ground and of 3,930 to 4,920 ft/min at 50,000 ft. Meanwhile first details have been released of the *Leduc 022*, which is to be fitted with a swept wing (30 to 35º) and to have not only the ramjet engine but also a turbojet (probably an ATAR) for take-off and landing. The Leduc 022 should be able to reach Mach 2 both in climb and in level flight. Leduc hopes that fuel consumption can be kept below 2.5 lb/lb.t/hr at Mach 2 and high altitude.

● An increase in permissible gross weight for the *Bréguet 763* four-engined airliner and freight aircraft is announced. The machine may now be certificated at 113,760 lbs.

POWER PLANT

● American sources give a static thrust of 13,000 lbs for the *Rolls-Royce Conway* by-pass jet engine ; specific consumption is said to be 0.71 lb/lb.t/hr.

● The latest version of the Napier Nomad bears the designation *Nomad NNm.7* ; take-off power 3,467 s.h.p.

● Two new rocket take-off engines are announced : the *Scarab* and the *Ladybird*. The *Scarab* weighs 100 lbs and gives a thrust of 1,500 lbs for 6 seconds. The second engine delivers a thrust of 3,000 lbs and weighs 175 lbs ; burning duration 6 seconds.

● General Electric is working on a propeller turbine, the *T-58*, of " under 1,000 h.p. " for the U.S. Navy, a low-power turbojet for the Air Force and a high-performance turbojet of 30,000 lbs thrust with afterburning.

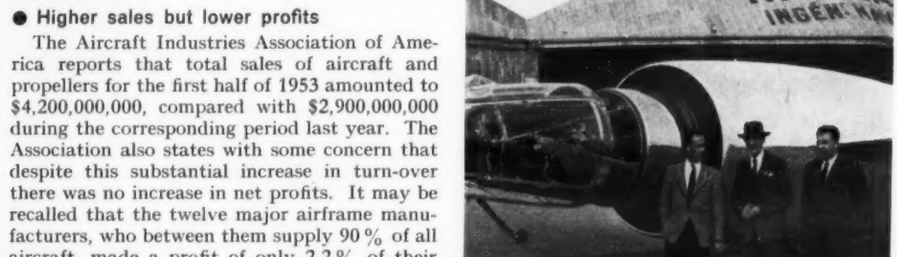
ACCESSORIES AND EQUIPMENT

● Mullard Ltd., London, has developed a fully automatic *radar sonde* for meteorological observations in the upper air : measurement of wind force and direction ; temperature measurements ; pressure and humidity readings.

● Simon Equipment Ltd., London, announce that their tape recorder type *LDT.7* is particularly suitable for use at small airfields. Low cost, simple, cheap maintenance and low operating costs are stressed.

● Development of a " Fatigue Meter " is announced by the Royal Aircraft Establishment, Farnborough. Fitted at an aircraft's centre of gravity, the instrument records accelerations occurring in flight and thus enables stresses to be watched. A number of prototypes of the Fatigue Meter (weight 3.5 lbs) have been fitted experimentally in the Vickers *Viscount*.

● *Selcall* (Selective Calling System) is the name of a new instrument for communication between ground and aircraft developed by the Pacific-Alaska group of Pan American World Airways. It enables the ground station to enter into communication with any desired aircraft by means of a coded call sign. Cost of equipment : $1,500 for ground station and $500 for aircraft equipment.



McDonnell XF3H-1 *Demon* single-seat Navy fighter.

The Piloted Delta-Wing Interceptor

One of its major design problems

BY ALAIN BURET, CHIEF ENGINEER, SOCIÉTÉ NATIONALE
DE CONSTRUCTIONS AÉRONAUTIQUES DU NORD

(Concluded) *

Delta-wing interceptor balanced by trailing edge flaps

The fundamental difference between the delta-wing aircraft balanced by trailing edge flaps and conventional aircraft balanced by a horizontal tailplane is that the *static longitudinal stability margin* [1] in the former must be considerably reduced in order to keep lift losses due to upward deflection of the flaps within acceptable limits.

The direct inter-dependence between the static stability margin and the lift coefficient of the aircraft in balanced condition is illustrated in *fig. 2*, which shows the variations in lift and moment coefficients as a function of angle of attack for various deflections of the trailing edge flaps, for the tailless delta-wing aircraft A in *fig. 1*. It will be seen that for an *initial static stability margin of 11 %*[2], balancing at an angle of attack of 17° 30′ requires an upward flap deflection of 15° and entails a reduction in lift coefficient of the balanced aircraft of $C_z = 0.15$, or a 21 % reduction in the lift obtainable with zero deflection of the flaps. This reduction would increase sharply if a static stability margin of more than 11 % were demanded, and the maximum efficiency limit of the flaps would soon be reached ; it would be slighter if a smaller static stability margin were accepted. The static stability margin of conventional aircraft is at least in the region of 15 %. The value of 11 % appears to be the top limit in the delta-wing aircraft with trailing edge flaps, beyond which lift is reduced to an unacceptable degree.

If a given landing approach speed is to be obtained with an acceptable value for the static stability margin, the reduction in lift due to the flap deflection can only be combated in aircraft A by a *very considerable increase in wing area.* The result is an increase in structural weight on the one hand, and an increase in drag on the other.

Concerning structural weight, although it is true that a certain increase in the wing's thickness resulting from the bigger wing area enables higher torsional and flexural rigidity values to be obtained, this rigidity must be still further increased in order to absorb the heavy aerodynamic loads from the trailing edge control surfaces and avoid the structural deformation which leads to reversal of these controls. Moreover, to overcome the problems of flutter, the trailing edge control surfaces must be statically balanced and, in the case of servo controls, there are further rigidity requirements which are complicated by the unavoidable length of the control circuits and the small thickness of the wing. All these requirements lead to increases in structural weight.

Where drag is concerned, since the area presented to the air flow is greater and the relative thickness of the airfoil is limited to an approximate minimum of 5 % by rigidity and production considerations, there is an increase in drag which has its effects throughout the speed range. For given aircraft specifications this increase in drag entails at least an increase in weight and volume of fuel, if not an increase in thrust and weight of power plant.

Furthermore, the necessity of limiting the longitudinal static stability margin to a low value affects the design of the whole of the aircraft by its effect on permissible C.G. travel. This is a serious handicap in an interceptor with its very high fuel consumption. To allow for the volume of power plant, fuel tanks and wing structure, the wing must be fitted relatively far ahead of the rear of the fuselage, and the latter must also be increased in length. All this again increases weight and drag.

As all these inter-dependent factors have a " snowball " effect, the result is that for a given landing approach speed the pure delta-wing aircraft balanced by trailing edge flaps will have a substantially greater wing area and weight than a conventional aircraft balanced by horizontal tail unit.

Another characteristic of the pure delta-wing aircraft with trailing edge flaps is the variation in static stability margin with Mach number *(fig. 4)*. The static stability margin increases with the Mach number [3] and at Mach 1.4 is nearly three times its value at low speed. The result is a tendency to excessive stability at supersonic speeds and a consequent difficulty in manœuvring.

The effect of the trailing edge flap deflection and the limited balancing power of these flaps also influence the behaviour of maximum utilizable lift coefficient in relation to Mach number. *Fig. 5* shows the marked reduction in this coefficient at the beginning of the transonic range ; the pure delta's greater wing area, compared with the conventional aircraft's, can only just make up for the low values of the coefficient.

Finally, it should be noted that from the point of view of longitudinal *dynamic* stability, the pure delta-wing aircraft with trailing edge flaps has very much reduced damping values at low supersonic speeds. This factor has an unfavourable effect on the aircraft's qualities as a gun platform.

Delta-wing interceptor balanced by all-flying rear elevator unit

The first difficulty encountered in this configuration is the determination of the optimum position of the rear elevator unit. As the latter runs the risk of being affected by the wing backwash and the vortices behind the trailing edge, it has in a number of cases been fitted very high, on top of the fin. So as to obtain maximum balancing power, the rear elevator unit must be of the all-flying variety and of large area because of the small lever arm.

This two-fold necessity for an elevator unit of large area and of its location on top of the fin, involves considerable difficulties in its installation. Flutter in the fuselage-fin-elevator assembly necessitates an increase in the thickness of the fin and added rigidity of the structure. It also eliminates the effect of sweepback in the fin,

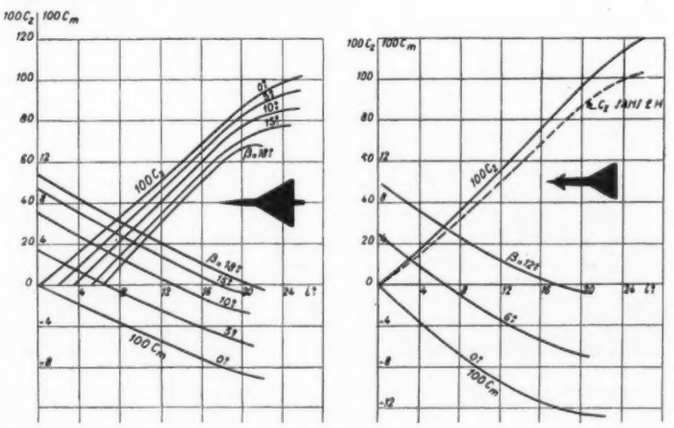
[1] *Static longitudinal stability margin* is the distance between the aircraft's centre of gravity and its so-called focal point, expressed, in the present case, as a percentage of the mean geometric wing chord. The aircraft's focal point is the point in relation to which the pitching moment coefficient remains practically constant. The mean geometric chord considered here takes into account the part of the wing occupied by the fuselage.

[2] *Initial static stability margin* is the value of the static stability margin at low speed and in normal configuration (with zero deflection of the balancing control surfaces).

[3] This results from the definition of the static stability margin, and is due to the backward movement of the focal point with increasing Mach number.

* *Cf.* " INTERAVIA, Review of World Aviation ", No. 11, 1953, pp. 664-665.

Figs. 2 and 3 : " Pure " delta-wing aircraft (aircraft A ; left) with trailing edge flaps over 15 % of wind chord, and " canard " delta-wing aircraft (aircraft B ; right) both with different elevator deflections. The broken curve (right) applies to aircraft B without elevator unit.



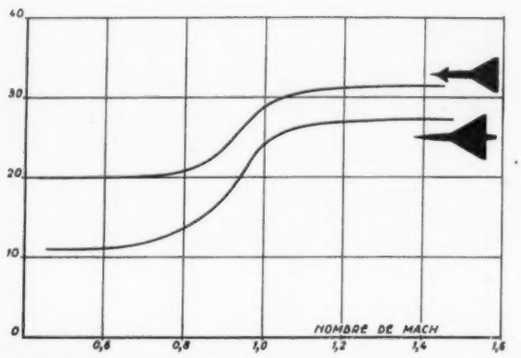


Fig. 4 : Maximum permissible static stability margin, in aircraft A and B, plotted against Mach number. The maximum static stability margin (at which control surface deflections can still just balance the aircraft) is expressed as a percentage of the mean geometric chord.

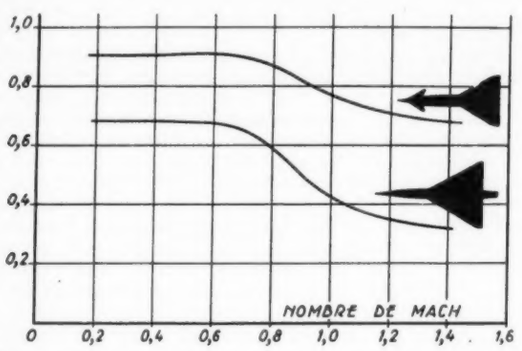


Fig. 5 : Maximum utilizable lift coefficient in the balanced aircraft (aircraft A and B) plotted against Mach number

produces interference drag and flutter, and finally leads to an increase in the length of the servo control circuits. In addition, at high angles of attack the masking effect of the wing unit and fuselage tend to cancel out the efficiency of the horizontal tail plane.

*

But, can this rear elevator unit in the delta-wing aircraft also be considered as a stabilizer ? The angle of downwash of a delta wing with sharp sweep and low aspect ratio is large, and its value is very close to that of the aircraft's angle of attack. Consequently, the effective angle of attack of the tail plane varies extremely little with the aircraft's angle of attack, so that this tail plane has small effect, if any, on longitudinal stability. The aircraft must therefore be stable by itself without the tail, the latter acting only as a balancer. The static stability margin of the aircraft when balanced is only slightly superior to that of the pure delta wing, because of the greater lever arm in the case of the tail unit. For all the angles of attack superior to the angle at which the aircraft can be balanced without the tail, the tail unit must balance the diving moments, thereby reducing the aircraft's lift by 8 to 10 %.

Bearing in mind also the effect of the weight of the rear tail plane and the extra weight of the fuselage rear on the aircraft's weight and its centre of gravity position, American criticisms of the practice of balancing a delta-wing aircraft by a tail plane would appear to be justified.

Delta-wing interceptor balanced by all-flying forward elevator unit

Since the focal point in a delta wing is relatively far back, the greatest effect from an elevator unit can be obtained by placing the latter in the nose of the aircraft.

An aircraft with such an elevator unit will have a greater total lift than an aircraft without it. Fig. 3 shows, for the delta-wing aircraft B with forward elevator unit in fig. 1, the variations in lift and moment coefficients as a function of angle of attack for various deflections of the forward all-flying elevator unit. It will be seen that with an initial static stability margin of 20 %, balancing at an angle of attack of 17° 30′ requires a 12° deflection of the elevator and produces an increase in lift coefficient of 0.075, or 10 % compared with the tailless aircraft. Moreover it should be stressed that the balance is obtained here with an initial static stability margin of 20 %, which is higher than that of conventional aircraft.

The balancing efficiency of a forward elevator in a delta-wing interceptor has been confirmed by a large number of wind tunnel tests carried out on a half-model attached to the wall at low and transonic speeds and on a complete model with very thin support at supersonic speeds.

The advantage of this method of balancing compared with the two methods discussed above is immediately obvious. The relative figures for balancing by means of trailing edge flaps and of forward elevator are as follows :

	Aircraft A	Aircraft B
Lift coefficient of balanced aircraft at angle of attack of 17° 30′	0.63	0.83
Variation in lift coefficient due to balancing	−21 %	+10 %
Initial static stability margin	11 %	20 %

Thus, for a given landing approach speed, the wing area required in " canard " delta-wing aircraft B is substantially smaller than that required in " pure " delta-wing aircraft A, with aircraft B having a very marked superiority in initial static stability margin.

It may be objected that allowance must also be made in aircraft B for the supplementary weight and drag caused by the elevator. However, this objection is invalidated by the following considerations,

— High lever arm of the forward elevator, enabling balance to be obtained with a small area ;

— Reduction in wing structural weight thanks to the elimination of trailing edge control surfaces and their reversal and flutter dangers ;

— Virtual elimination of the harmful effects of elevator reversal ;

— Reduced tendency to flutter and reduction in weight due to the ease with which the forward elevator can be statically balanced and to the short servo control circuits ; this means optimum conditions of rigidity and irreversibility.

All these factors taken together help to reduce weight and drag on the aircraft ; by the opposite " snowball " effect to that discussed for the pure delta, they produce the following results for the same interceptor specification :

— *The wing area in the " pure " delta-wing aircraft A is 60 % greater than that of " canard " aircraft B ;*

— *The wing area of the pure delta-wing aircraft A is 40 % greater than the sum of the wing and forward tail plane areas in " canard " delta-wing aircraft B ;*

— *The weight of pure delta-wing aircraft A is 16 % higher than that of " canard " delta-wing aircraft B.*

If we examine the variations in static stability margin with Mach number for the aircraft with forward elevator (fig. 4), we see that it also increases with the Mach number, but less steeply than in the " pure " delta-wing aircraft. Thus, at Mach 1.4 it is only 1.5 times its value at low speeds. The difficulty in manœuvring towards supersonic speeds therefore increases less steeply in " canard " aircraft B.

Fig. 5 shows that, in the case of " canard " aircraft B, because of the smaller increase in static stability margin with increasing Mach number, the maximum utilizable lift coefficient decreases less rapidly than in the case of " pure " delta A. At high Mach numbers the absolute value of the maximum utilizable lift coefficient is much greater in aircraft B than in aircraft A, in spite of the former's much smaller wing area.

Finally, as regards longitudinal *dynamic* stability, the absolute damping values are very much higher than those of the " pure " delta, because of the forward elevator's greater lever arm. The damping obtained is also superior to that of the conventional aircraft with rear tail unit.

The " canard " configuration has many opponents, and it must be admitted that the few experiments made with this type of aircraft

before the war did not produce the results hoped for. It should, however, be pointed out that none of these earlier designs had the following features :

— long pointed fuselage nose ;
— small fuselage diameter at attachment of elevator unit ;
— wing and tailplane with sharp sweep and low aspect ratio.

A common objection to the " canard " configuration is that the flow breaks away on the tailplane earlier than on the wing. However, with the tail and wing designs used in the interceptor contemplated, this objection loses its fundamental validity, as break-away does not occur until very high angles of attack, which are never reached, either in pulling our or in tight turns. Wind tunnel tests have shown, moreover, that, thanks to the pointed fuselage and the elevator's sharp sweep-back, there is no local instability, as has been demonstrated in particular by tests on the fuselage and elevator without wings.

Finally, it should be stressed that the extensive experiments made by Société MATRA on " canard "-type missiles have overcome all anxieties as to these missiles' behaviour at high subsonic, transonic and supersonic speeds.

Conclusions

The piloted interceptor will be needed in the immediate future, either as a transition between present conventional fighters and future robot aircraft, or to work alongside ground-to-air missiles, for some considerable time to come, on complementary defence missions.

This interceptor must be of minimum dimensions, weight and cost. To obtain minimum drag conditions, the delta-wing configuration should be adopted. But the problem of logitudinal manœuvrability and balance in such delta-wing aircraft is an acute one, since the method of balancing reacts strongly on dimensions, weight and cost.

A comparison of balancing by trailing edge flaps (" pure " delta-wing aircraft), by rear all-flying elevator unit and by forward all-flying elevator unit (" canard " delta-wing aircraft) leads to the conclusion that the last-mentioned configuration is by far the best. Its superiority takes the form of a marked reduction in wing area and a substantial saving in the structural weight of the aircraft.

This is the result to which our tests and experiments have led. Moreover we do not appear to be alone in our views, since Mr. B. A. Hunn, of Hawker Aircraft arrived at the same conclusion in a paper read to the last International Aeronautical Congress in Paris.

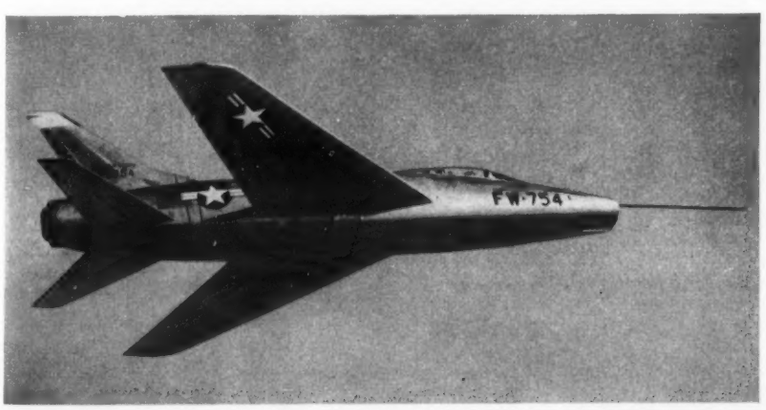
F-100, the Fastest Fighter in the World

On October 20th, the first production model of the North American F-100 *Super Sabre* supersonic interceptor was completed. Nine days later Lieutenant Colonel F. K. " Pete " Everest set up a new world speed record in the YF-100 prototype over a 15-km measured base at Salton Sea, California. On two measured runs he obtained an average speed of 1,215.02 km/h (754.98 m.p.h.) and thus beat the speed reached by a Navy Douglas XF4D-1 *Skyray* on October 3rd by 2.6 km/h.

Although the YF-100 prototype began flight testing on May 25th this year, very few technical details have been released. However, pictures on this page show that the *Super Sabre*, in production for the U.S. Air Force, has a 45° swept wing of small thickness ratio. The tail unit is also sharply swept, and the horizontal plane, which is entirely movable, sits strikingly low on the rear fuselage. It is also known that the *Super Sabre* has a span of 36 ft., a length of 45 ft. and a height of 14 ft., and that it is said to be the first U.S.A.F. production fighter capable of exceeding Mach 1 in level flight. At low altitude, however, maximum speed would appear to be only in the high subsonic range. At roughly 30,000 ft. on the other hand speeds of around Mach 1 are said to be possible, while at operational altitude (" more than 50,000 ft.") speeds of Mach 1 + are expected.

On October 29th Lieutenant Colonel F. K. " Pete " Everest set a new world speed record of 1,215 km/h in the YF-100 prototype of the North American *Super Sabre* jet fighter. Picture shows the YF-100 shortly before landing. Wing slots and U-shaped brake underneath fuselage are open.

Up to now the YF-100 prototype has been flight tested with a Pratt & Whitney J-57-P-1 turbojet whose maximum thrust was no more than 8,500 lbs. Even the record flight was made with this engine. The F-100 production model, however, is to be fitted with the more powerful J-57-P-7 of approx. 9,500 lbs. static thrust dry, or 14,000 to 15,000 lbs. with reheat. It should therefore be possible to justify the high hopes placed in it—supersonic speeds in level flight and very high climbing performance.



Left, the *Super Sabre* has a wing span of 36 ft. and an angle of sweep of 45°. Length 45 ft., height 14 ft. *Right*, George Welch, North American Aviation Inc. test pilot, is responsible for testing the F-100. Here he is climbing into the first production model, which is powered by a Pratt & Whitney J-57-P-7 of approx. 9,500 lbs. static thrust dry, or 14,000 to 15,000 lbs. with reheat. The YF-100 prototype set up the new world record with a J-57-P-1 engine of only 8,500 lbs. thrust.

The mind of Mr. Reader...

Sir,

In view of the two articles " But Me No Buts " and " A Buckshee Ride " in your October number, some clarification of the rules regarding free and reduced rate transportation on the scheduled international airlines may be in order.

As you know, international fares are the product of unanimous agreement between the airlines in the I.A.T.A. Traffic Conferences and become effective upon approval by interested governments. In order to maintain these fare levels, it is necessary as well to define rather exactly when it is permissible to provide transport free or at reduced rates and when it is not. These rules and regulations, which are vital to the existence of the agreed rate structure, are contained in I.A.T.A. Traffic Conference Resolution 200, which like the fares resolutions themselves, must also have government approval.

Since the effectiveness of I.A.T.A. action in the traffic field depends upon the unanimous consent of all parties—airlines *and* governments—concerned, the opposition of any one of them is in effect a veto on Conference action. It is the case that the airlines have twice attempted in resolutions unanimously agreed by them in 1951 and 1952 to make provision for free and reduced transportation for the press, subject to certain necessary controls, but the resolution had each time been disapproved by the United States Civil Aeronautics Board. CAB disapproval has meant that no U.S. flag carrier—and no other carrier serving the United States—can be a party to such an agreement, and thus that the regulations as they stand cannot be changed.

I think it is safe to say that this situation is as unsatisfactory to the member airlines of I.A.T.A. as it seems to be to Georges Fevrier or to Cassiopeia. The airlines and I.A.T.A. are very cognizant indeed of the value of a well informed press and of the fact that it is difficult for a journalist to write with authority and understanding about the problems of international airline operation without some opportunity to observe them at first hand. Nevertheless, the situation is beyond our control.

It is difficult to say whether any amelioration will be possible. The CAB's attitude is governed by the strictures of the U.S Civil Aeronautics Act against discriminatory rate practices and, lest you should think that the effect of the rule is felt by the press alone, it extends as well to a similar prohibition of " Principal's privilege "—the right which the presidents and heads of virtually all other forms of transport have always enjoyed to have guests on their own services.

Yours sincerely,
S. RALPH COHEN,
Public Relations Officer,
International Air Transport Association,
Montreal, Canada.

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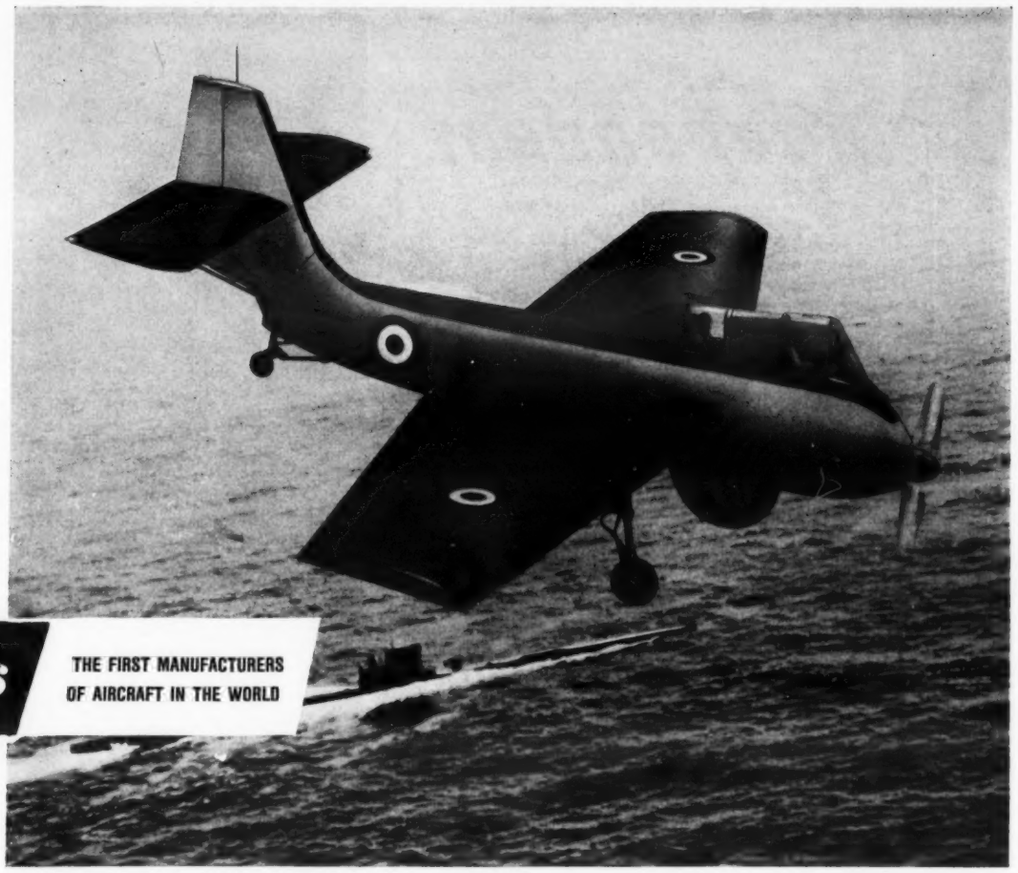

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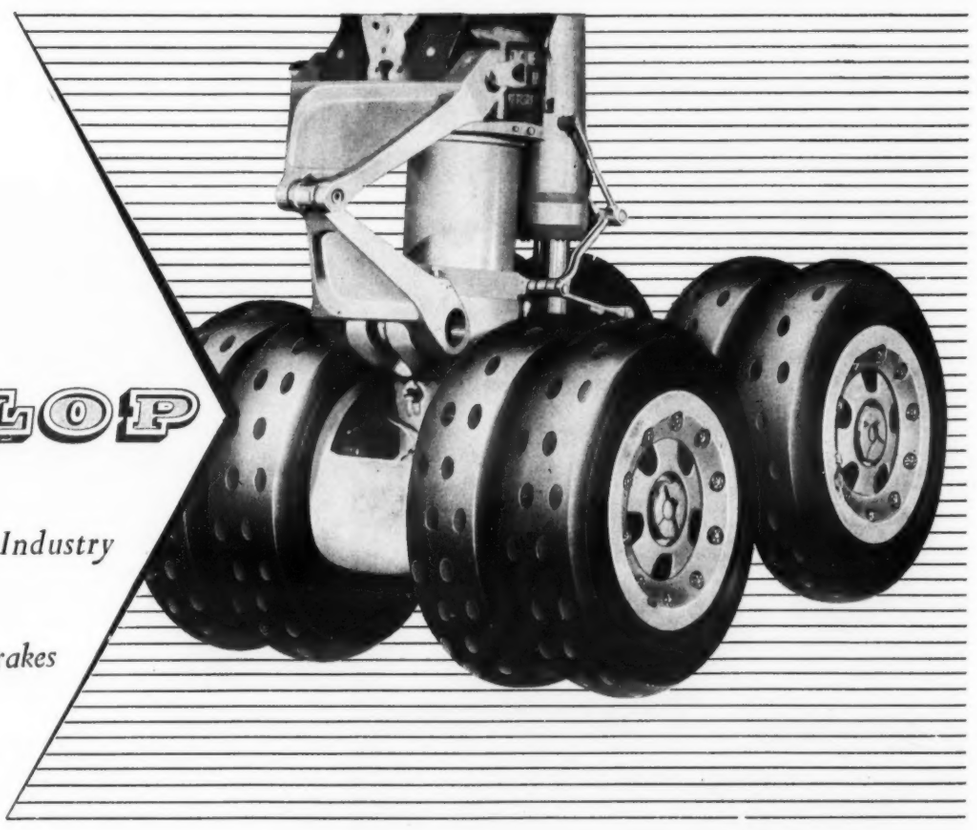

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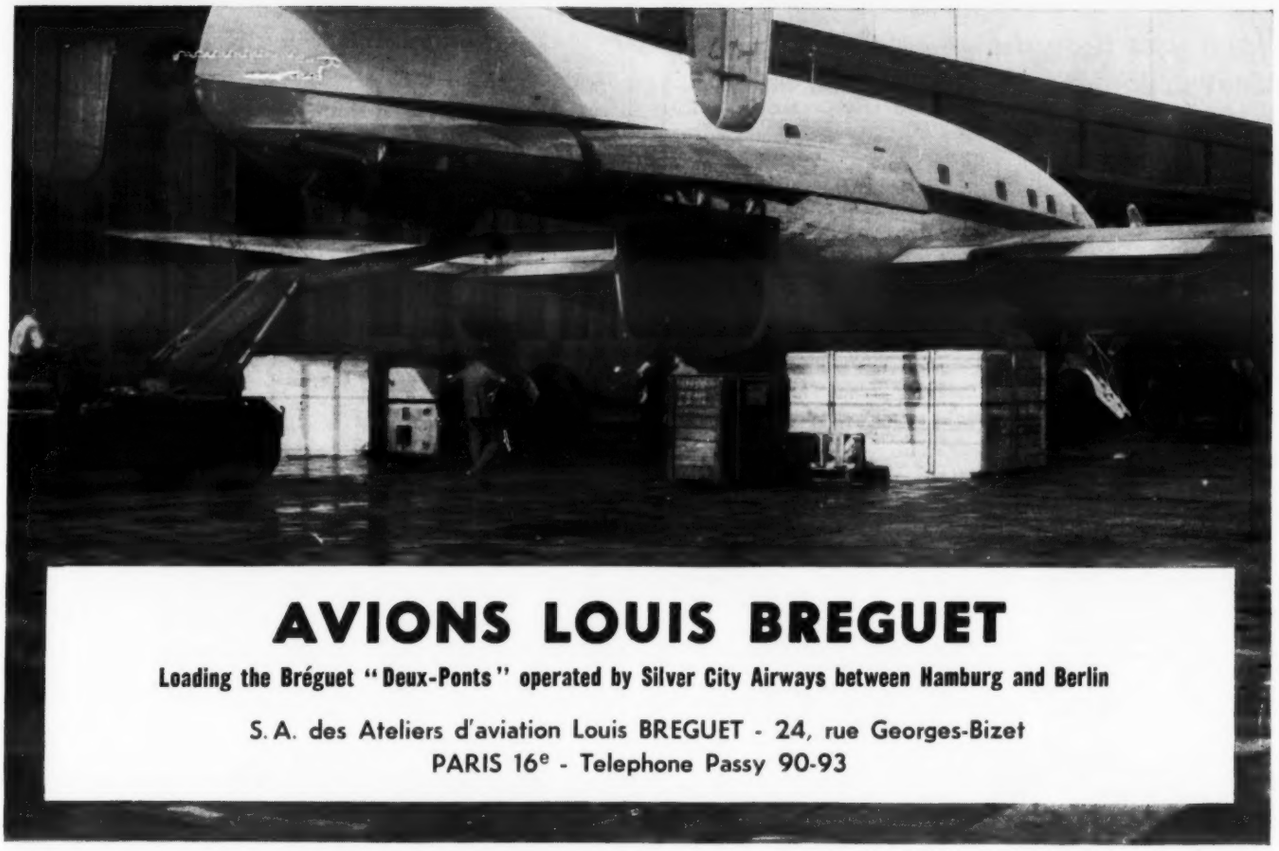

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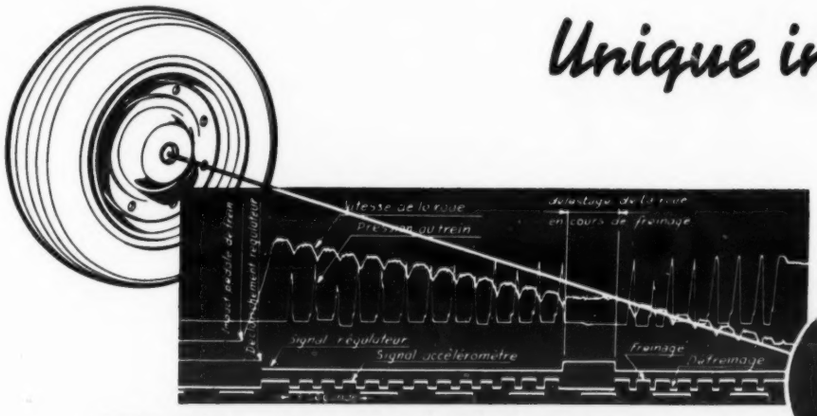

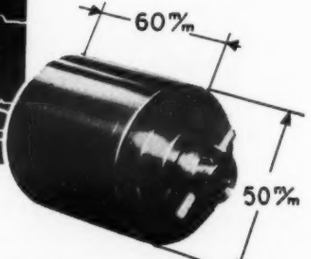

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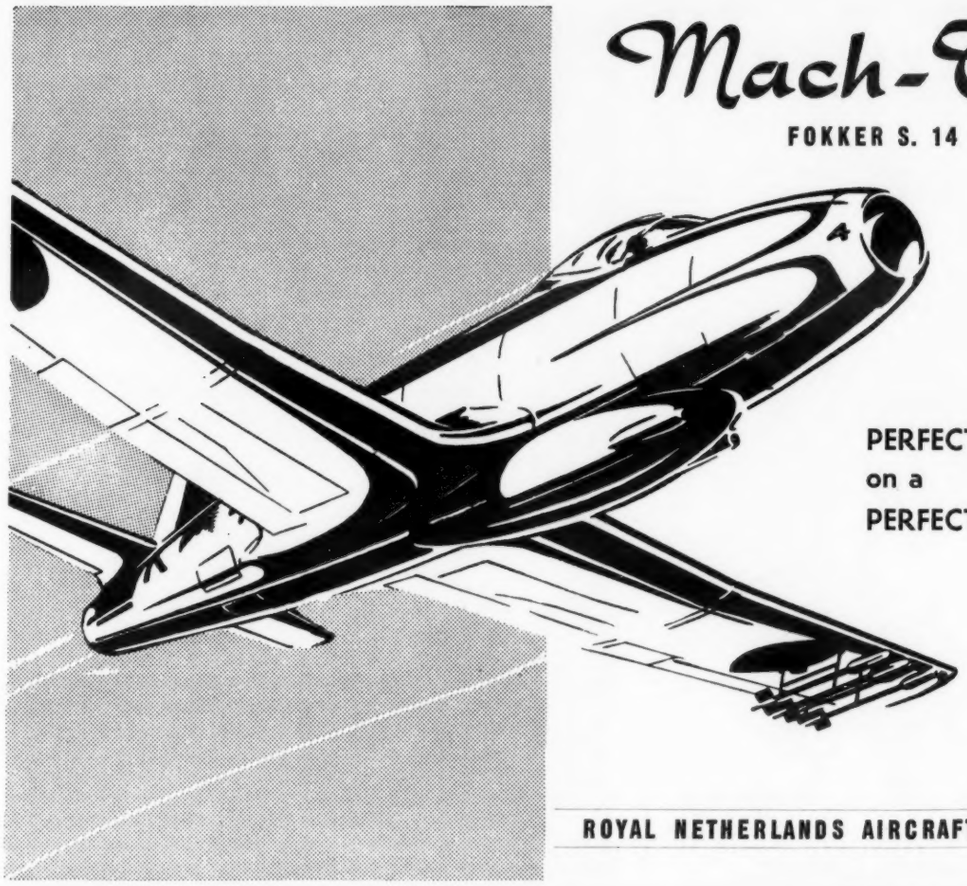

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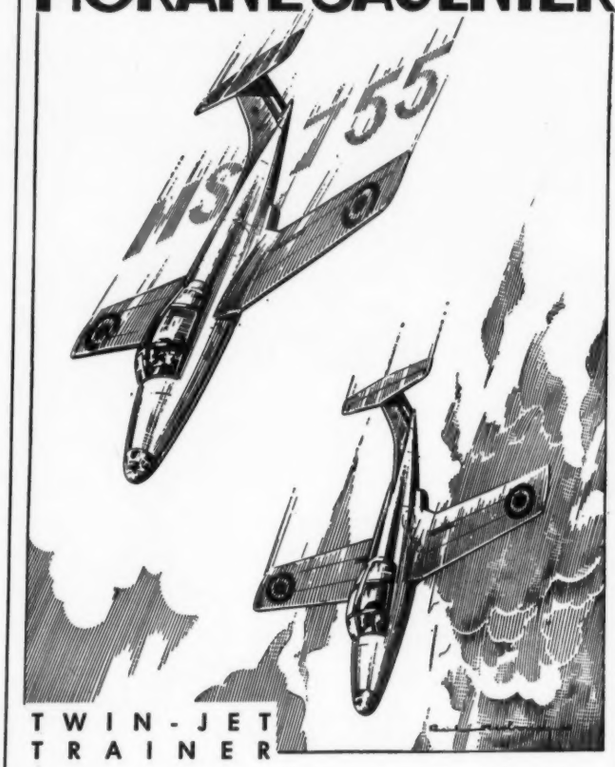

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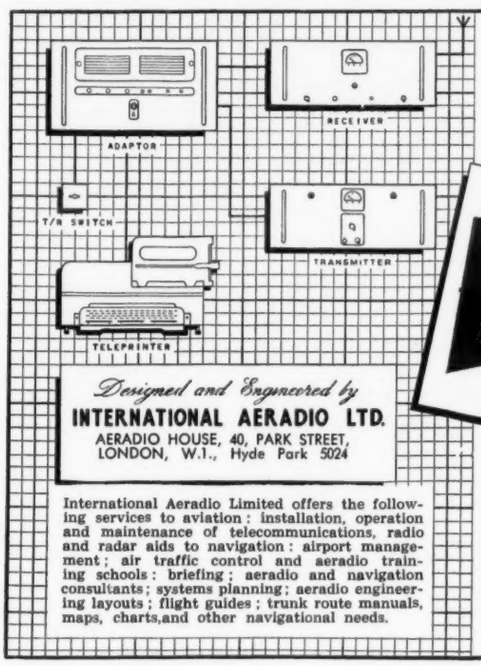

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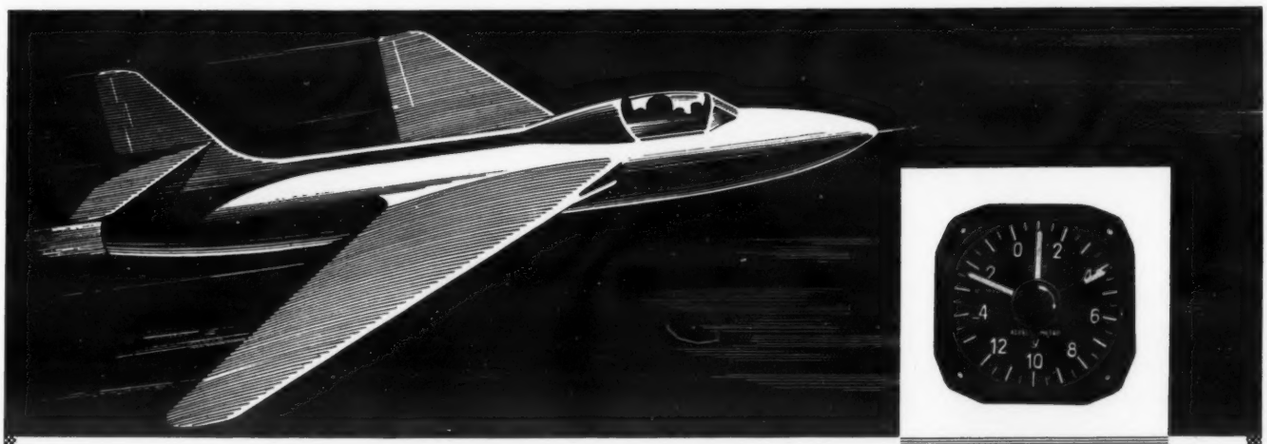

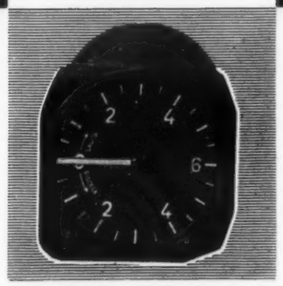

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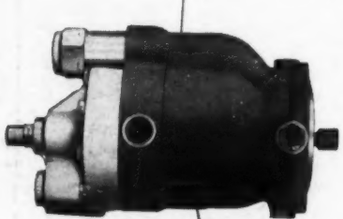

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